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## COVER

*Ctenocolletes smaragdinus* (Smith, 1868). This large iridescent green solitary bee occurs in heaths of inland southern WA and its range has contracted due to loss of habitat. It belongs to the small family Stenotritidae, which occurs only in Australia. The pen and ink drawing was done by Anne Hastings, an illustrator who has worked at the Australian National Insect Collection in CSIRO since 1983. Anne worked with fellow illustrator, S.P. Kim, on illustrations for the 1991 2<sup>nd</sup> edition of *Insects of Australia* and this was one of the drawings used in that work. Taxonomic illustration has changed dramatically since then and Anne now works with various computer software packages to enhance and reconstruct digital images and helps to produce online identification tools and material for the scientists at the ANIC.

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## THE *LOPHOCOLEUS* GROUP OF GENERA (LEPIDOPTERA: EREBIDAE: HERMINIINAE) IN FIJI, WITH THE DESCRIPTION OF A NEW GENUS AND SPECIES

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### Abstract

Three related endemic moth genera from Fiji: *Lophocoleus* Butler, *Tholocoleus* Robinson and *Palaeocoleus* Robinson, are reviewed and descriptions and illustrations of the females and their genitalia are provided. An additional new genus and species, *Archaeocoleus namosii* gen. n. & sp. n., is described and illustrated from both sexes.

### Introduction

The endemic erebid moth genus *Lophocoleus* Butler is of particular interest as it shows considerable radiation in Fiji. It was described by Butler (1886), who included only his new species *L. mirabilis* Butler. Robinson (1975) described five further new species in the genus, illustrated the males and provided a guide to their identification based on the male genitalia. Robinson (1975) also introduced two new monotypic genera: *Tholocoleus* Robinson, to which he assigned the endemic species described by Butler (1886) as *Lophocoleus? astrifer* Butler; and *Palaeocoleus* Robinson, to which he assigned the endemic species described by Butler (1886) as *Bocana synnoides* Butler.

Robinson's (1975) descriptions of these eight species are completed here by illustrations and descriptions of the females, including their internal genitalia. Significant differences in the female genitalia provide a reliable guide to the separation of the species, which supports Robinson's classification based on the male genitalia.

A previously undescribed species was discovered that can be assigned to this group of genera. It does not precisely agree with the diagnosis of any of the three presently recognised genera and differs in several characteristics from the species currently assigned to them. The species appears, at least superficially, to be most closely related to *Lophocoleus*, but it differs from it sufficiently that a new genus, *Archaeocoleus*, is erected to accommodate it. The new species is described here as *Archaeocoleus namosii*.

### Materials and methods

A regular programme of light trapping was carried out during the period 1991-1998. This was used to sample the moth fauna at various forest locations in eastern Viti Levu, Fiji. The locations ranged in altitude from sea level to 900 m. A battery powered trap was employed, using a 6W actinic tube as light source. This allowed easier access to more remote locations. A small number of further visits were made up to 2013.

The collection resulting from this work has been studied and has resulted in a series of papers including the descriptions of a number of new taxa (Clayton 2002, 2008, 2010, 2011). The current paper is the latest in this series.

### **Systematics**

The classification followed here is that of Zahari *et al.* (2012), which has superseded that of Kitching and Rawlins (1999). This treats the Herminiinae as a subfamily of the Erebidae rather than of the Noctuidae.

### **Family Erebidae**

### **Subfamily Herminiinae**

### **Genus *Lophocoleus* Butler, 1886**

Butler (1886) erected this genus on the basis of the bipectinate male antennae and the modified male foreleg. The first tarsal segment is enormously elongated and a tibial sheath extends almost to the end of this first segment. Robinson (1975) extended this diagnosis by including characters of the male genitalia. The valves are broad and truncated apically and a variety of dorsal and ventral apical processes are diagnostic at species level; in the aedeagus, the vesica bears a striking group of heavily sclerotised cornuti, the precise arrangement and form of these structures again being diagnostic at species level. Robinson (1975) described five new species to add to Butler's *L. mirabilis*; he also described the males of all six species, which he illustrated together with the valves and the groups of cornuti.

The forewings vary from generally blackish brown to a brighter orange-brown, with a variety of generally somewhat obscure markings. The contrasting hind wings are generally pale greyish or greyish brown with some darker shading towards the termen; there is no sexual dimorphism in colouration or markings. The females do, however, have unmodified forelegs and filiform antennae. Somewhat unusually, the females are consistently smaller than the males.

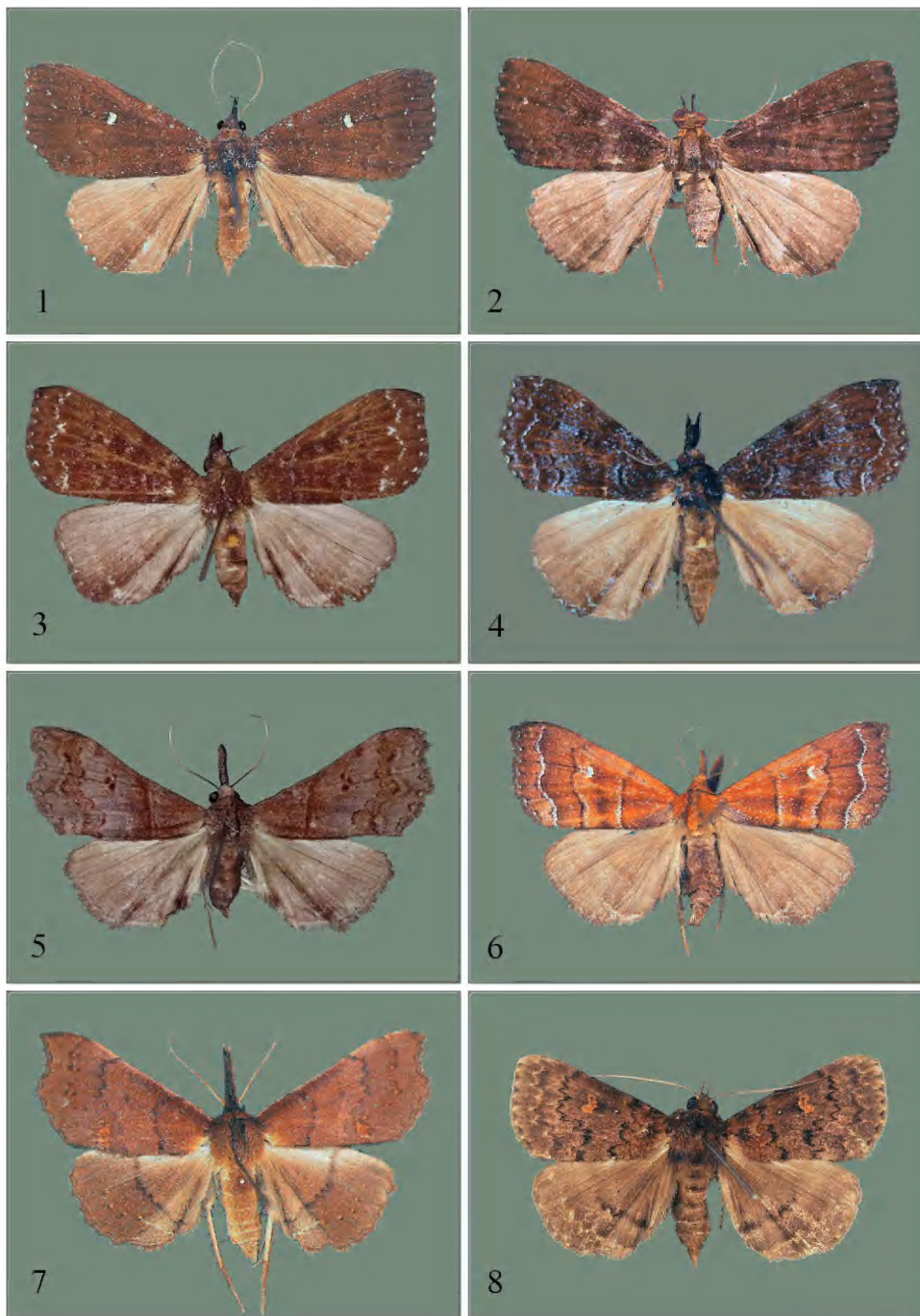
In the female genitalia, the sterigma and ductus show little structure with only light sclerotisation and provide no diagnostic features. However, the bursa copulatrix is quite striking and provides excellent features for diagnosis to species level. The shape varies and there are generally one or two strongly sclerotised areas, plus an area containing a large number of small, star-shaped denticles which comprise the signa.

### ***Lophocoleus mirabilis* Butler, 1886**

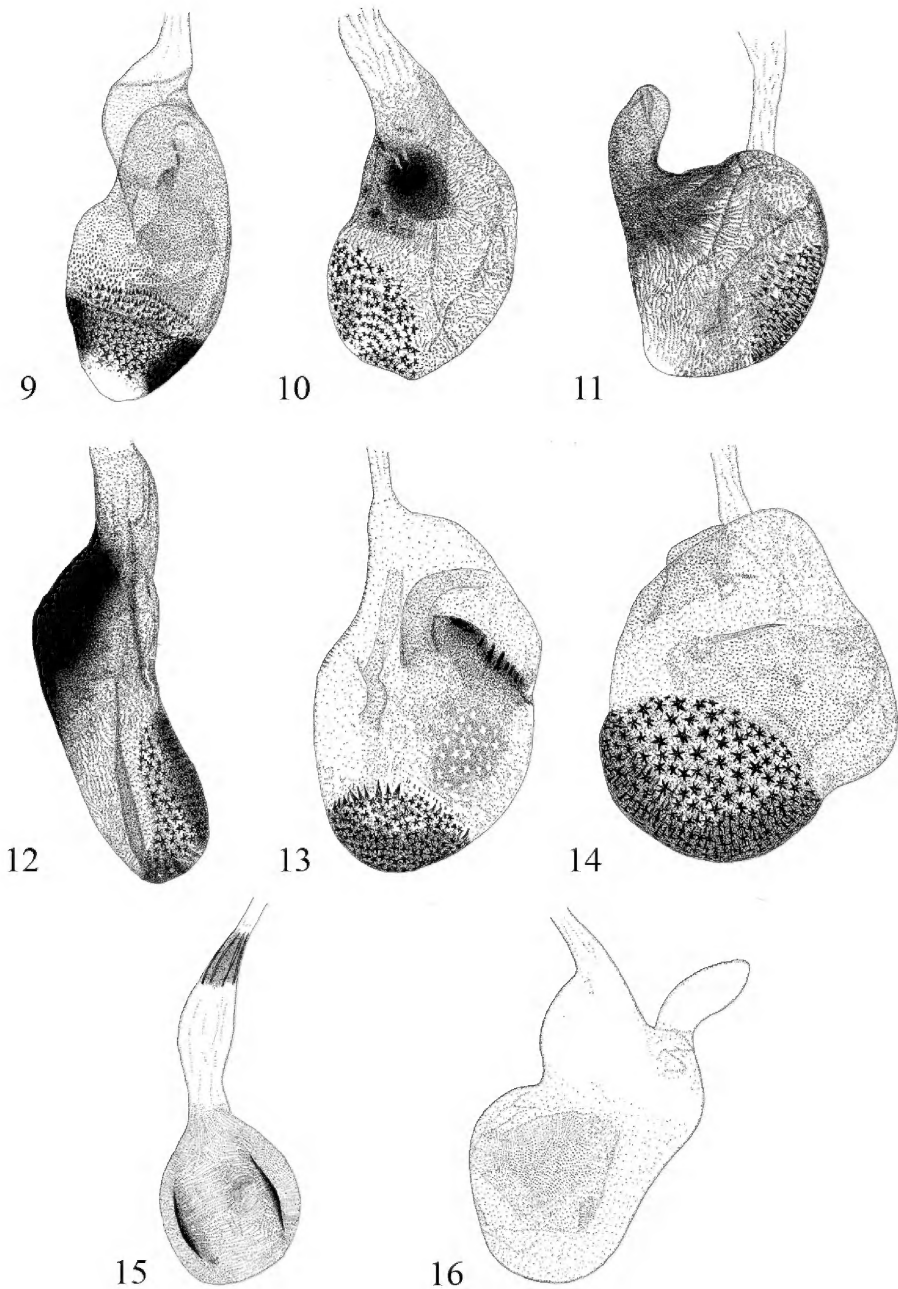
(Figs 1, 9)

*Diagnosis.* Forewings mid-brown with only very faint darker basal and postmedial lines; a prominent whitish reniform stigma is diagnostic, not being present in any other *Lophocoleus* species.





**Figs 1-8.** *Lophocoleus* group females. (1) *Lophocoleus mirabilis*; (2) *L. suffusa*; (3) *L. albipuncta*; (4) *L. iridescens*; (5) *L. acuta*; (6) *L. rubrescens*; (7) *Tholocoleus astrifer*; (8) *Palaeocoleus synpoides*.



**Figs 9-16.** *Lophocoleus* group: bursa copulatrix of females. (9) *Lophocoleus mirabilis*; (10) *L. suffusa*; (11) *L. albipuncta*; (12) *L. iridescentis*; (13) *L. acuta*; (14) *L. rubrescens*; (15) *Tholocoleus astrifer* (including ductus); (16) *Palaeocoleus synpoides*.

*Male*. Described by Robinson (1975: 232, plate fig. 177, text figs 95, 101).

*Female* (Fig. 1). Wingspan 38 mm. Patterned as male. Genitalia with bursa copulatrix (Fig. 9) generally rounded, twice as long as broad; signa a band of many small star-shaped denticles around apical third, but leaving tip unmarked; several diffuse areas of scobination.

*Occurrence*. Only a single female was taken, in primary rainforest on the main island, Viti Levu, close to Suva. Robinson also found this species to be very scarce, despite it being the only *Lophocoleus* taken by Butler.

### ***Lophocoleus suffusa* Robinson, 1975**

(Figs 2, 10)

*Diagnosis*. Forewings plain mid-brown with only very faint darker basal, postmedial and subterminal lines.

*Male*. Described by Robinson (1975: 233, plate fig. 188, text figs 97, 103).

*Female* (Fig. 2). Wingspan 35-38 mm. Patterned as male. Genitalia with bursa copulatrix (Fig. 10) generally rounded, one and a half times as long as broad; signa a circular area of small star-shaped denticles in apical half; a slightly smaller circular dark area present in the basal half; the remainder covered in light scobination.

*Occurrence*. Small numbers taken in various rainforest locations in eastern Viti Levu, from low levels to 1000 m.

### ***Lophocoleus albipuncta* Robinson, 1975**

(Figs 3, 11)

*Diagnosis*. Forewings mid to dark brown; basal and postmedial lines more clearly defined than in *L. suffusa*; subterminal line white; sharply dentate between M1 and M2 leaving a clear, detached white V-shaped mark. Some specimens show a suggestion of blue iridescence in the pale markings and could be confused with worn specimens of *L. iridescens*, but this lacks the V-shaped mark, having the subterminal line continuous between M1 and M2.

*Male*. Described by Robinson (1975: 231, plate fig. 186, text figs 98, 104).

*Female* (Fig. 3). Wingspan 35-40 mm. Patterned as male. Genitalia with bursa copulatrix (Fig. 11) approximately as long as broad, with a prominent lateral appendix; signa an area of small star-shaped denticles opposite appendix; various degrees of scobination over most of the surface, somewhat darker around the base of the extension.

*Occurrence*. The most numerous of the six *Lophocoleus* species, taken in various rainforest locations in eastern Viti Levu.



***Lophocoleus iridescens* Robinson, 1975**

(Figs 4, 12)

*Diagnosis.* Forewings dark brown, with darker basal and medial lines and pale subterminal line. Fresh specimens of *L. iridescens* are unmistakable due to areas of bright blue iridescence around the basal and medial lines; subterminal line also iridescent blue. Worn specimens lose the blue iridescence and superficially could be mistaken for *L. albipuncta* (q.v.).

*Male.* Described by Robinson (1975: 231, plate fig. 183, text figs 93, 96, 102).

*Female* (Fig. 4). Wingspan 35-39 mm. Patterned as male. Genitalia with bursa copulatrix (Fig. 12) three times as long as broad; signa an area of small star-shaped denticles on one side, from midpoint to apex; a dark sclerotised area basally opposite signa; remainder with various degrees of scobination.

*Occurrence.* Small numbers taken in various rainforest locations in eastern Viti Levu, from 200 m to 900 m.

***Lophocoleus acuta* Robinson, 1975**

(Figs 5, 13)

*Diagnosis.* One of three species under consideration with a markedly concave forewing termen. The bright orange-brown colouration and markings are diagnostic and show little variation.

*Male.* Described by Robinson (1975: 230, plate fig. 184, text figs 100, 106).

*Female* (Fig. 5). Wingspan 27-32 mm. Patterned as male. Genitalia with bursa copulatrix (Fig. 13) generally rounded, one and a half times as long as broad; signa a circular area of small star-shaped denticles apically; a sclerotised diagonal band at basal one third; between this band and the signa, an area of light scobination with an ordered array of pale, star-shaped markings, appearing like the inverse of the dark star-shaped teeth of the signa.

*Occurrence.* Small numbers taken in various rainforest locations in eastern Viti Levu, from low levels to 1000 m

***Lophocoleus rubescens* Robinson, 1975**

(Figs 6, 14)

*Diagnosis.* One of three species under consideration with a markedly concave forewing termen. The dull orange-bronze colouration and markings, together with the orbicular stigma consisting of three dark brown dots, are diagnostic.

*Male.* Described by Robinson (1975: 232, plate fig. 189, text figs 99, 105).

*Female* (Fig. 6). Wingspan 33-34 mm. Patterned as male. Genitalia with bursa copulatrix (Fig. 14) generally rounded, a little longer than broad; signa a circular area of small star-shaped denticles covering apical third; this area larger, and the denticles individually larger, than in other *Lophocoleus* species; this area also bulging somewhat from the main shape of the bursa copulatrix; remainder covered by light scobination; no other sclerotised areas or significant markings.

*Occurrence*. Small numbers taken in various rainforest locations in eastern Viti Levu, from 200 m to 1000 m.

***Archaeocoleus* gen. n.**

Type species *Archaeocoleus namosii* sp. n., by present designation.

Possesses many of the characters of *Lophocoleus* Butler but lacks the modification of the male foreleg. In addition, the valves of the male genitalia lack a truncate apex and apical processes and the bursa copulatrix of the female genitalia lacks a signa.

***Archaeocoleus namosii* sp. n.**

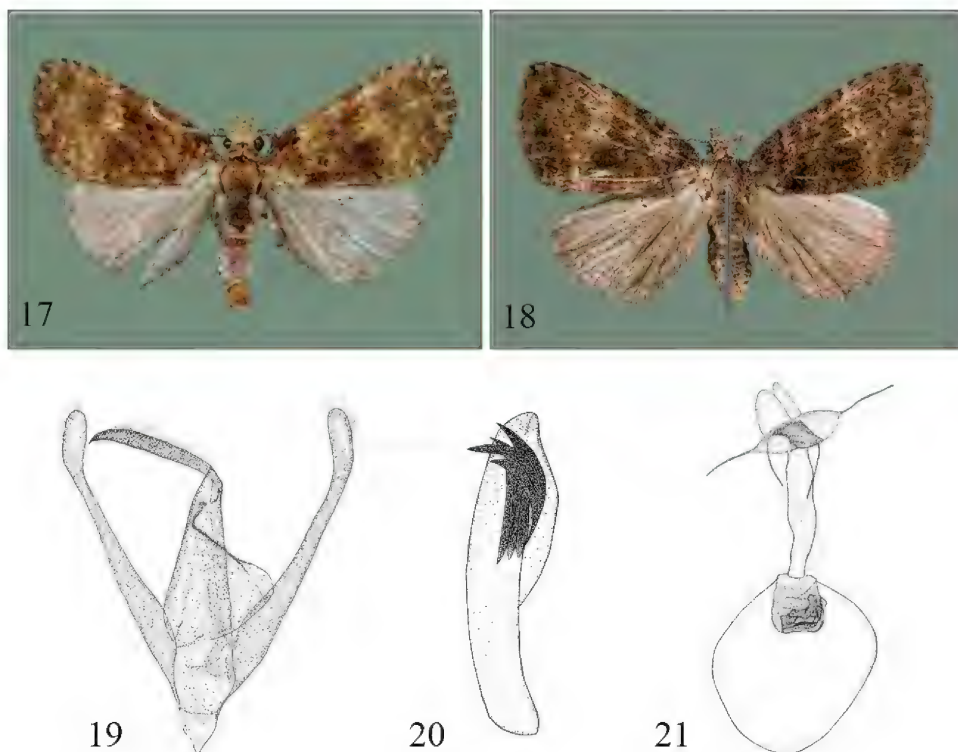
(Figs 17-21)

*Types*. *Holotype* ♂, FIJI: Viti Levu, Namosi Highlands, grid ref. N29/4075, 31.i.98, at light, J.A. Clayton. *Paratypes*: 2 ♂♂, same data as holotype except 26.ii.97 and 25.i.98; 2 ♀♀, same data as holotype except 17.vi.95 and 14.ix.96. All types and genitalia slides have been deposited in the National Museums of Scotland, Edinburgh.

*Description*. Male (Fig. 17): Wingspan 19-23 mm. Head and antennae buff. Thorax light brown. Abdomen buff. Antennae bipectinate. Labial palps upturned, short, reaching level of eyes; first two segments bearing long scales; short third segment less heavily scaled. Forewings broadly triangular; costa largely straight, slightly bowed towards apex.; apex obtuse; termen convex; yellowish buff more or less irrorated with dark brown; irroration heavier in basal half of wing; a terminal series of five whitish streaks extending from apex; reniform stigma a pale figure-of-eight shape filled with buff; orbicular stigma a small dark brown spot; the area between the stigmata shaded dark brown; a dark brown patch between reniform stigma and dorsum. Hind wings uniform pale buff.

The genitalia are shown in Fig. 19. Valves simple and narrow, about eight times as long as broad; uncus mainly straight and of equal width throughout; a downcurved spine at the tip; aedeagus (fig. 20) with a prominent group of six curved, heavily sclerotised cornuti.

*Female* (Fig. 18): Wingspan 27-33 mm. Antennae bipectinate. Similarly patterned to the male. Forewings less yellowish than the male; brown markings darker. Hind wings more greyish brown and somewhat darker than the male.



**Figs 17-21.** *Archaeocoleus namosii* sp. n. (17) male holotype; (18) female paratype; (19) genitalia of male holotype; (20) aedeagus of male holotype; (21) genitalia of female paratype.

The genitalia are shown in Fig. 21. Sterigma and ductus showing no features of diagnostic value; bursa copulatrix as long as broad; a sclerotised basal area considerably folded; otherwise without any ornamentation or areas of scobination.

The association between the males and females of this species is based on the detailed similarities in the markings, supported by being taken at the same location.

*Etymology.* The name *namosii* is derived from the fact that the type series was collected entirely in Namosi Province. The generic name *Archaeocoleus* suggests that it might represent a more primitive branch than *Lophocoleus* itself.

*Distribution.* Rainforest at a height of 200 m on Viti Levu.

*Taxonomy.* Some confusion was experienced in placing this species. Robinson (1975: 136) described a species, which he labelled as an 'Indeterminate species (Acronictinae)', known only from two males. One of the two specimens was in good condition, but missing the abdomen. He illustrated this in his plate fig. 340. The other was complete but in poor condition and he illustrated the genitalia and aedeagus of this, along with the fore and hind wing venation and antennae (his text figs 74-77). The male genitalia, aedeagus, wing venation and antennae of the current species agree with those illustrated by Robinson (1975). His description of the fore and hind wings and his illustration also agree. It is almost certain that the current species and that described by Robinson are the same.

Robinson (1975) gave no explanation as to why this species should be placed in the Acronictinae and indeed it is difficult to see why this should be so. Although he treated both the Herminiinae and the Acronictinae as part of the Noctuidae, the subfamilies are not closely related and bear little similarity. It is most likely that the placement was a simple error on Robinson's part. Zahari *et al.* (2012) did not recognise the Acronictinae as part of the Erebidae and it remains as part of the Noctuidae. The present species differs in lacking the characteristic colouration and facies of this subfamily, the forewing shape differs markedly and the body is more slender. The male genitalia have little in common with acronictine species and its overall appearance suggests placement in the Herminiinae. Although there is no accepted precise definition of this subfamily, it has traditionally been defined as being composed of quadrifine 'noctuids' with a pre-spiracular counter-tympanal hood. These features are present in the current species, so it is here placed in the Herminiinae.

Holloway (2008) discussed the Herminiinae genera in the Bornean context. Based on his classification, *A. namosii* cannot be placed in any of his genera. Apart from the three endemic genera in the *Lophocoleus* group discussed here, other Fijian Herminiinae genera are included in Holloway's discussion and are therefore excluded as possible candidates. *Archaeocoleus namosii* does not show all the characteristic features of any of the three genera in this group.

The wing shape and general appearance would place it in *Lophocoleus*. This is supported by the striking group of cornuti in the aedeagus. This is a feature not found in any other Herminiinae genus (or indeed consistently in any other erebid genera) described by Robinson or Holloway. However, in the male genitalia the valves lack the truncated apex and apical processes and in the female the bursa copulatrix lacks signa. Also, the male of *A. namosii* lacks the modified foreleg of *Lophocoleus* species. For these reasons, a new genus, *Archaeocoleus*, is proposed.

*Remarks.* Of the other species in the group, *A. namosii* most resembles *L. albipuncta* in general appearance. However, in addition to the differences summarised in the description of the genus *Archaeocoleus*, *A. namosii* lacks a distinct subterminal line in the forewings, which serves to separate it from *L. albipuncta* and other *Lophocoleus* species.

### **Genus *Tholocoleus* Robinson, 1975**

Robinson (1975) described this genus as being allied to *Lophocoleus*. The forewing termen is concave in the apical half, similar to *L. acuta*. The terminal segment of the male palp is greatly expanded and the male antennae filiform. The male foreleg is modified, similar to *Lophocoleus*. In the male genitalia the valves are rounded apically and the aedeagus has a group of terminal, thorn-like carinae but is lacking cornuti.

*Tholocoleus* differs from *Lophocoleus* in having the hind wings and forewings similarly coloured and marked. The males and females are of similar size and there is no sexual dimorphism in terms of colouration or markings. The female genitalia show no significant structure in the sterigma, but there is a sclerotised section in the ductus; the bursa copulatrix lacks the small, star-shaped denticles characteristic of the signa of *Lophocoleus*.

### ***Tholocoleus astrifer* (Butler, 1886)**

(Figs 7, 15)

*Diagnosis.* The palp length, wing shape and pattern are diagnostic.

*Male.* Described by Robinson (1975: 238, plate fig. 176, text figs 94, 107, 109).

*Female* (Fig. 7). Wingspan 44-48 mm. Patterned as male. Antennae filiform and foreleg unmodified. Genitalia (Fig. 15) with sclerotised section towards basal end of ductus; bursa copulatrix generally rounded, a little longer than broad; two longitudinal signa running over half the length of bursa copulatrix; remainder covered by light scobination; no other sclerotised areas or significant structures.

*Occurrence.* Small numbers taken in various rainforest locations in eastern Viti Levu, from 500 m to 1000 m.

### **Genus *Palaeocoleus* Robinson, 1975**

Robinson (1975) described this genus as being allied to *Lophocoleus*. It has a more mottled appearance and more rounded wings. The terminal segment of the male palp is twice that of *Lophocoleus* but smaller than in *Tholocoleus*. Male antennae bipectinate, but with segments one to five filiform and six to nine unipectinate. Modified male foreleg similar to *Lophocoleus* and *Tholocoleus*. Male genitalia with valves truncated and with apical processes, similar to *Lophocoleus*; aedeagus plain; vesica with fine scobination only.



*Palaeocoleus* is intermediate between *Lophocoleus* and *Tholocoleus* in appearance in having the hind wings somewhat paler than the forewings, but reflecting their markings. As in *Lophocoleus*, the females are consistently smaller than the males. The female genitalia show no significant structure in the sterigma or ductus; the bursa copulatrix is somewhat irregularly shaped, but with no significant markings.

***Palaeocoleus synnoides* (Butler, 1886)**

(Figs 8, 16)

*Diagnosis.* The more rounded wing shape and pattern are diagnostic.

*Male.* Described by Robinson (1975: 235, plate fig. 1764 text figs 108, 110).

*Female* (Fig. 8). Wingspan 32-37 mm. Patterned as male. Antennae filiform and foreleg unmodified. Genitalia (Fig. 16) with bursa copulatrix very lightly marked and flimsy in nature, approximately twice as long as broad, somewhat irregular in shape; a narrow subbasal appendix; some areas of very light scobination; no signa or other significant structures.

*Occurrence.* Good numbers taken in various rainforest locations in eastern Viti Levu and Vanua Levu from lower levels to 500 m, but not taken in more montane forest locations. After *L. albipuncta*, this is the commonest species in the group.

**Acknowledgements**

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## PHOTOGRAPHIC RECORD OF FEMALE *ALLORA MAJOR* ROTHSCHILD (LEPIDOPTERA: HESPERIIDAE) AT IRON RANGE NATIONAL PARK

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### Abstract

A female *Allora major* (Rothschild, 1915) was photographed at Iron Range National Park on 28 June 2014, the first such record from the Australian mainland. The photograph also documents interesting male behaviour.

### Introduction

*Allora major* (Rothschild, 1915) is known in Australia only from Iron Range, Cape York Peninsula, Queensland (Braby 2000, 2004). On 27 and 28 June 2014, specimens were observed while on a 10 day expedition to photograph butterflies in Iron Range National Park.

On 28 June, both a male and a female were observed and photographed (Fig. 1). The male was subsequently netted. This is the first published record of a female of *A. major* from the Australian mainland.

### Observations

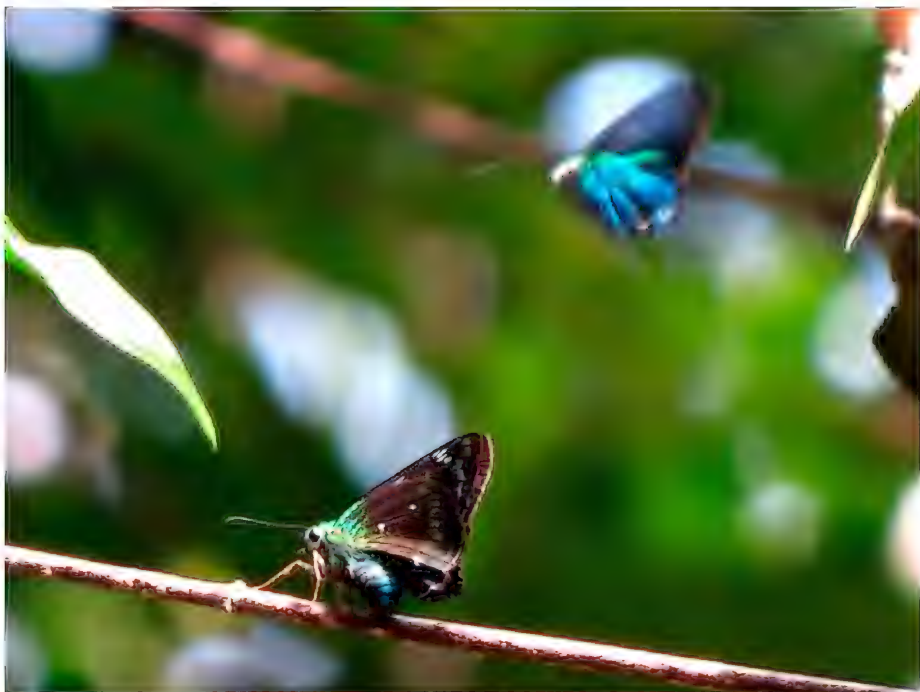
On 27 June 2014, while searching the roadside at 12.7266S 143.2847E (ca 1.6 km south of the Rainforest Camp Turnoff), an *Allora major* was seen in ascending flight at approximately 1030h. We recognised it by its larger size and greater colour intensity than *Allora doleschallii* (C. Felder, 1860), which was observed in similar ascending flight at another site 8 km north of Coen on 24 June 2014.

On 28 June 2014, at 1020h at the first location, two specimens of *A. major* were observed flying high in the canopy. One then perched on a horizontal section of vine about 6 m above the ground; the other was flying around in close proximity just above it. FP photographed the specimens while GW went to collect net extensions.

FP took seven photographs, including that shown in Fig. 1, after which both butterflies flew along the roadside to the north, descending to 1.5 m above ground level, just as GW was returning. GW gave chase, the butterflies turned and began flying to the south, and he managed to catch the male.

Fig.1 was taken with a hand held Canon Powershot SX50HS compact digital camera set at x42 optical zoom (equivalent 35 mm focal length of 1024 mm), with shutter speed of 1/40 second, ISO of 200 and aperture of 6.5.

Further photographs of both the female and the male are provided on GW's website at: <http://australianbutterfliesphotographed.com/>



**Fig. 1.** Female *Allora major* with male hovering above – photographed at Iron Range on 28 June 2014.

### Discussion

From Fig. 1 it is obvious, from the body size, that the stationary butterfly is a female. The photograph shows the series of subapical spots on the forewing underside and the subapical spot on the hindwing underside, which distinguish it from the similar *A. doleschallii* (Braby 2004). The third distinguishing feature, the white subternal patch on the forewing underside, cannot be seen but the netted male had this consistent with *A. major*.

The female is evidently probing the substrate, either laying eggs or testing its suitability for oviposition. The male is clearly exhibiting courtship behaviour. Since he was netted, we cannot be sure what the outcome of this interaction might have been had the butterflies been left undisturbed, but it seems likely the female was unreceptive and was exhibiting an escape response.

Braby (2000) noted that ‘The females are not known from Australia’ and there have been no records of a female on the mainland published since 2000 (Cliff Meyer, Grant Miller and Peter Valentine pers. comms. July 2014).

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## **A RANGE EXTENSION FOR *EUREMA ALITHA* (C. & R. FELDER) (LEPIDOPTERA: PIERIDAE) IN AUSTRALIA, WITH NOTES ON THE MIGRATORY BEHAVIOUR OF *EUREMA* SPECIES IN SOUTH-EAST QUEENSLAND**

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### **Abstract**

Two specimens of *Eurema alitha* (C. & R. Felder) collected at Buderim, Queensland, provide a new southern distribution record for this species. One of these specimens was collected among other migrating *Eurema* Hübner species, although it remains unclear whether *E. alitha* is a migrant. Observations on the migratory behaviour of other *Eurema* species in south-east Queensland are also presented.

### **Introduction**

The presence of *Eurema alitha* (C. & R. Felder, 1862) in Australia was first recognised by Braby (1997), who determined that this species had been collected in Australia since the early 1900s but had been confused with *Eurema hecabe hecabe* (Linnaeus, 1758) due to their similar wing patterns. *Eurema alitha* has a tropical distribution in Australia (Braby 1997, 2000, Jones 1999), with specimens collected as far south as River Heads, north-east of Maryborough, Queensland (Dunn 2007).

### **A new southern distribution record for *Eurema alitha***

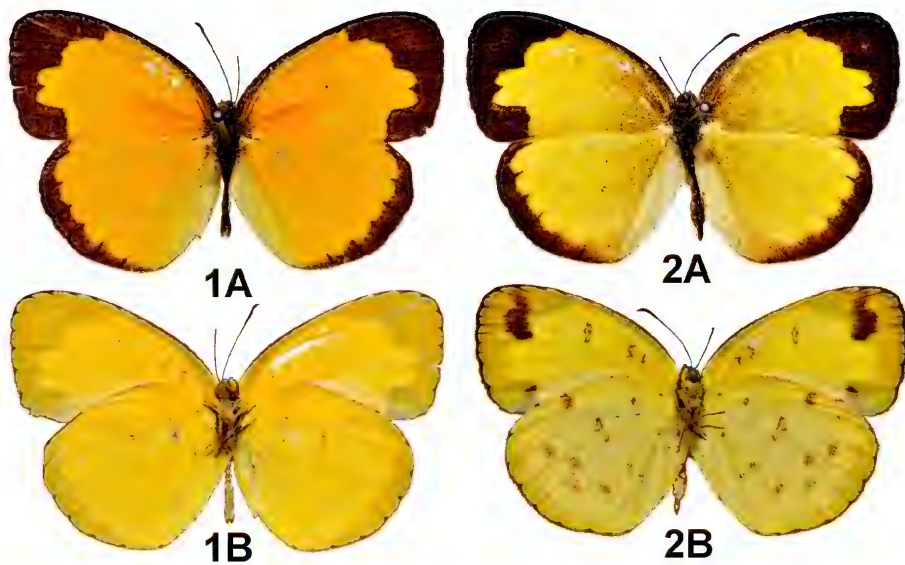
Two specimens of *Eurema alitha* were collected at the same location at Buderim (26°39'59.88"S 153°3'37.66"E), Queensland in 1997 and 1999. The 1997 specimen was a male (Fig. 1) collected in early December, the second (Fig. 2) a female collected on 27 March 1999 from a migratory group comprised of several *Eurema* Hübner species. These specimens represent a range extension of approximately 135 kilometres south of the previous record by Dunn (2007).

### **Notes on the migratory behaviour of *Eurema* in south-east Queensland**

Although a number of *Eurema* species have been recorded as migratory in Australia, few observations of their behaviour have been published (Braby 2000). I was able to observe a migratory flight in 1999, from which the female *E. alitha* was taken, in some detail at a number of locations across the Sunshine Coast district. On 25 March 1999, I observed butterflies at a site in Nambour (26°38'42.06"S 152°57'31.34"E) throughout the day. At about 1430h, I noticed that the number of *Eurema* present had increased abruptly and that their flight behaviour had changed. Normally, *Eurema* species have a strongly jinking flight that changes direction every few seconds, making their overall flight path hard to predict. In contrast, these butterflies had a more direct flight with less jinking and individual specimens arrived from the north and moved towards the SSW in a more-or-less straight line. Numerous *Eurema* specimens, showing identical behaviour, were subsequently observed



at Dulong, Montville and Mapleton on 26 March 1999, Buderim on 27 March 1999 and Beerwah on 8 April 1999. Opportunistic sampling of the migration at Buderim on 27 March showed it to be comprised of *E. alitha*, *E. brigitta australis* (Wallace, 1867), *E. hecabe hecabe* and *E. smilax smilax* (Donovan, 1805). The latter three species have been regularly encountered on the Sunshine Coast previously (pers. obs. and A.G. Orr pers. comm.). *Eurema* species showing migratory behaviour were not observed after 8 April 1999.



**Figs 1-2.** Specimens of *Eurema alitha* collected at Buderim, southeastern Queensland: (1A) ♂ upperside; (1B) ♂ underside (Buderim Qld, December 1997, coll. J.E. Nielsen); (2A) ♀ upperside; 2(B) ♀ underside (Buderim, Qld, 27 March 1999, coll. J.E. Nielsen).

### Discussion

In addition to representing a 135 kilometre range extension, the female of *E. alitha* figured above represents the first record of this species associated with a migration. Various *Eurema* species have been observed to migrate in Asia, Africa and the Americas, with migrations often comprised of mixed species (Yata 1989). However, no literature was found recording migrations of *E. alitha* in Australia or elsewhere, while observations of this species in northern Australia suggest it is relatively sedentary (M.F. Braby pers. comm.). Braby (2000) and Jones (1999) summarised available information on *Eurema* migrations in Australia and regarded all Australian *Eurema* species except *E. alitha*, *E. herla* (Macleay, 1826) and *E. puella* (Boisduval, 1832) as opportunistic migrants.

As only one specimen of *E. alitha* was taken during the 1999 *Eurema* migration, it is unclear whether it was migrating, undertaking a coincidental non-migratory movement in search of hosts, or merely a vagrant. It is feasible that *E. alitha* may exploit host plants outside its normal distribution during favourable conditions. It is worth noting that the presence of the female *E. alitha* specimen (and *Eurema* migration) followed above-average rainfall on the Sunshine Coast (Bureau of Meteorology 2014). This rainfall may have promoted growth of *Eurema* host plants, providing favourable conditions for immigrant butterflies. The only known Australian host of *E. alitha*, *Glycine tabacina* (Fabaceae) (Braby 2000), is widely distributed in Queensland, including the Sunshine Coast, New South Wales, Victoria and Western Australia (PlantNet 2014). As it is difficult to distinguish *Eurema* species in flight due to their similar wing patterns, comprehensive sampling is needed to provide more information on the migratory behaviour of *Eurema* in Australia, including *E. alitha*.

Given the specimen records available, it is likely *E. alitha* is either uncommon or not normally present in southeastern Queensland. Despite extensive collecting on the Sunshine Coast between 1992 and 2005, I did not observe specimens of *E. alitha* other than those discussed here. Dunn (2007) concluded that *E. alitha* is best considered a vagrant in southeastern Queensland, based on targeted collecting. However, the possibility remains that the similarity between *E. alitha* and *E. hecabe hecabe* continues to cause the presence of *E. alitha* in this region to be overlooked. Further records are needed to determine the resident status of *E. alitha* in this area.

### Acknowledgements

I am grateful to Brian Clarke for his company in the field, to Fabian Douglas, Kelvyn Dunn and Geoff Waite for access to literature, and to Albert Orr and Michael Braby for helpful discussions and permission to reference their unpublished observations. Albert Orr also reviewed drafts of this manuscript.

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## SEXUAL MORPHS OF *APHIS ACAENOVINAE* EASTOP, 1961 (HEMIPTERA: APHIDIDAE: APHIDINAE)

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### Abstract

The previously unknown sexual morphs of the Australian aphid *Aphis acaenovinae* Eastop, 1961 are described from specimens collected on *Geum urbanum* (Rosaceae). The species is monoecious, producing wingless males and oviparae on its summer host.

### Introduction

*Aphis acaenovinae* Eastop occurs only in Australia, on *Acaena ovina* (Eastop 1961), *Acaena anserovina* and *Geum urbanum* (all Rosaceae), and has been collected from all these during summer (Hales 2008). It is one of only four described species of indigenous Aphidinae and, like the others, is placed in the tribe Aphidini.

Barcode evidence based on cytochrome oxidase 1 (Genbank accession EU201295) (Foottit *et al.* 2008) links *A. acaenovinae* with the recently described *Aphis carverae* Hales, Foottit & Maw (in press) and to *Casimira canberrae* (Eastop), both known only from Australia (Teulon *et al.* 2013). No barcode sequence is available for the fourth Australian species, *A. platylobii* Carver & White. The Aphidini of Australia and New Zealand are highly unusual and have been proposed as possibly ancestral to the much more numerous and often economically important species of this tribe in the Northern Hemisphere (Eastop 2001, von Dohlen and Teulon 2003), although more data are needed before this hypothesis can be tested against the alternative, preferred by Eastop, that Australasian aphidines represent an outpost of a group originating in the north.

Aphids exhibit a range of complex annual cycles. Holocycly is the condition of having a complete annual cycle including parthenogenetic generations, sexual forms and eggs. A holocyclic monoecious species, after multiple parthenogenetically produced generations, remains on its summer host to produce males and mating females (oviparae), which lay eggs on the same host, the eggs being the only overwintering stage of the life cycle. Other possible annual cycles for aphids include continuous parthenogenesis (anholocycly) and holocyclic heteroecy. The latter is characterised by the use of separate hosts, whereby eggs are laid by mating females in autumn on one host, usually woody, and spring parthenogenetic generations arising from the eggs migrate to summer host plants, where they reproduce parthenogenetically, before returning to the winter host in autumn.



**Figs 1-2.** *Aphis acaenovinae*: (1) male; (2) ovipara. Scale bars = 200  $\mu$ m.



The annual cycle of *A. acaenovinae* has not been described previously and the sexual morphs were unknown. Males and oviparae were collected from *G. urbanum* in April 2008 at Thredbo, in the alpine region of New South Wales, and are described below.

Abbreviations: A 1-6 = Antennal segments 1-6; Ab 1-8 = Abdominal segments 1-8; ht2 = Second segment of hind tarsus; URS = Rostral segments iv+v ('ultimate rostral segment'); pt = Processus terminalis.

Units: Micrometres are used for measurements of setae and tubercles and millimetres for all other measurements.

### *Aphis acaenovinae* Eastop, 1961

*Male* (Fig. 1).

Described from 5 specimens collected ex *Geum urbanum* at Thredbo NSW (coordinates -36.505 and 148.308, altitude 1380 m above sea level) 17.iv.08 by DFH.

*Colour in fresh material.* Dark green; genitalia and cauda black; brownish around siphunculi; eyes dark brown. Siphunculi, legs, A3 light brown; legs darker at femoro-tibial articulation, tarsi and distal ends of tibiae. Antennae darker from mid-A3 to end of antenna. Distal part of rostral segment iii and URS black.

*Pigmentation of specimens preserved in 80% ethanol.* Head, antennae, genitalia, anal plate, URS, siphunculi, cauda and legs pigmented. A3, A4, femora and tibiae darker distally. Thoracic pleura pigmented. Spiracular plates pigmented. A few small dark markings on dorsal surface of thorax. Sternite 8 and genitalia black.

*Measurements.* Body length from frons to tip of anal plate 1.2-1.3 mm. Frons appears flat in mounted specimens. Length of antennae 0.9-1.0 mm. Antennae 0.72-0.83 times body length. A3 0.21-0.23 mm, basal diameter A3 0.014-0.018 mm, A4 0.15-0.17 mm, A5 0.16-0.17 mm, base of A6 0.10-0.11 mm, pt of A6 0.18-0.21 mm, pt/base 1.75-2.05. Longest seta on A3 10-12  $\mu$ m. Secondary rhinaria distribution: A3 6-8, A4 3-7, A5 1-4. Dorsal cephalic setae 8-12  $\mu$ m. URS length 0.12-0.126 mm, basal width 0.05-0.064 mm; single pair of secondary setae. Prothoracic tubercles 20- 36  $\mu$ m in height and 20-36  $\mu$ m in width. Tubercles on Ab1 18-28  $\mu$ m in height and 18-30  $\mu$ m in width. Tubercles on Ab 7 26-30  $\mu$ m in height and 22-30  $\mu$ m in width. Hind tibia 0.6-0.63 mm, ht2 0.086-0.096 mm, URS/ht2 1.3-1.4. Hind trochantro-femoral joint diameter 0.04-0.05 mm. Seta on hind trochanter 26-38  $\mu$ m, dorsal seta on hind femur 12-18  $\mu$ m, ventral seta on hind femur 24-28  $\mu$ m. Distal setae on hind tibia 28 -38  $\mu$ m; setae at mid-length of hind tibia 30-40  $\mu$ m. Siphunculi: length 0.23-0.38 mm, siphunculi 0.19-0.23 times body length, mid-width 0.022-0.026 mm, basal width 0.038-0.056 mm, apical width 0.024-0.028 mm, base/apex 1.46-2.33. Cauda slightly constricted about

40% of its length from the base. Cauda length 0.14-0.15 mm, basal width 0.094-0.106 mm (n=2), siphunculus/cauda 1.67-1.94, 5-7 setae on cauda. 2-4 setae on 8<sup>th</sup> abdominal tergite 10-14  $\mu$ m in length, setae on Ab 3 6-10  $\mu$ m. Anal plate with 12 setae to 36  $\mu$ m.

*Genitalia.* Claspers each with > 20 setae. Aedeagus not everted in available specimens.

Two further specimens were subsequently reared following a week on cut samples of the host plant. These were smaller (body length to tip of anal plate: 0.9-1.0 mm) than those developing in the field and their measurements are not included in the description above, although most other measurements and ratios fell within the range of those from larger specimens.

*Ovipara* (Fig. 2).

Described from 12 specimens collected ex *Geum urbanum*, Thredbo NSW 17.iv.08 by DFH.

*Colour in fresh material.* As for male but slightly lighter dull green. Genital plate bilobed and slightly pigmented on the sides. Ventral surface dirty fawn to green.

*Pigmentation of macerated specimens.* Head, antennae, cauda, anal plate, URS, siphunculi, cauda and legs pigmented although generally less so than in male. A3, A4, femora, tibiae, siphunculi darker distally. Spiracular plates pigmented. Without small dark markings on dorsal surface of thorax. Genital plate with dark area on each side.

*Measurements.* Body length from frons to tip of anal plate 1.60-1.86 mm. Antennal tubercles small with a short outward-facing seta on dorsal surface of each, frons sinuate with a small protuberance on each side of midline, a pair of anterior dorsal setae and a slightly more ventral inward-pointing pair whose bases are inset lateral to the median protuberances. Dorsal cephalic seta 8-12  $\mu$ m. Antennae 6-segmented, segments 1-2 smooth, 3-6 imbricated. Length of antennae 0.90-1.02 mm. Antennae 0.48-0.61 times body length. A3 0.20-0.23 mm, basal diameter A3 0.016-0.020 mm, A4 0.13-0.15 mm, A5 0.14-0.17 mm, base of A6 0.10-0.11 mm, pt of A6 0.18-0.23 mm, pt/base 1.75-2.05. Longest seta on A3 10-14  $\mu$ m. Secondary rhinaria nil. URS length 0.136-0.148 mm, basal width 0.054-0.066 mm. One pair of secondary setae 20-28  $\mu$ m long. Prothoracic tubercles 26-36  $\mu$ m in height. Marginal tubercles also on Ab1 (20-32  $\mu$ m in height, 20-40 in width) and 7 (26-40  $\mu$ m in height, 20-30  $\mu$ m in width). Hind tibia 0.63-0.68 mm, ht2 0.10-0.11 mm, URS/ht2 1.3-1.45. Hind trochantro-femoral joint diameter 0.046-0.054 mm. Seta on hind trochanter 26-40  $\mu$ m, dorsal seta on hind femur 12-20  $\mu$ m, ventral seta 22-36  $\mu$ m. Distal setae on hind tibia 34-48  $\mu$ m; setae from mid-length of hind tibia 34-42  $\mu$ m. Scent plaques on hind tibiae 11-49. Hind tibiae not markedly swollen, ratio of mid-length width to distal width 1-1.4. First tarsal segment

chaetotaxy 332. Siphunculi: length 0.32-0.38 mm, 0.19-0.23 times body length, mid-width 0.028-0.036 mm, basal width 0.05-0.08 mm, apical width 0.03-0.038 mm, base/apex 1.67-2.50. Cauda constricted about 4/10 of the distance from the base. Cauda length 0.18-0.23 mm, basal width 0.078-0.116 mm, siphunculus/cauda 1.69-1.96, 5-8 setae on cauda. 2-4 setae on 8<sup>th</sup> abdominal tergite, setae on abdominal tergite 3 8-10  $\mu$ m.

**Genitalia.** Gonapophyses 4, lateral gonapophyses large with 6 setae, medial smaller with 3-4 setae. Genital plate with 10-16 setae on general surface plus 14-27 marginal setae.

Siphunculi, cauda, anal and genital plate imbricated.

As with the males, additional specimens (n = 3) were reared from cut samples of *G. urbanum* but measurements are not included above. Body length (1.12-1.44 mm) was smaller than in field-grown individuals. Most other measurements and ratios fell within the ranges given above.

### Eggs

Light orange when seen through ovipara body wall and when first laid; of typical aphidine elongate-ovoid shape. Eggs are laid on leaves, stipules and stems of *Geum* and turn black after laying.

### Depositories

Specimens are deposited in the Australian National Insect Collection, Canberra, the Natural History Museum, London and the Canadian National Collection of Insects, Ottawa.

### Discussion

The discovery of wingless males, oviparae and eggs on a summer host, *G. urbanum*, clearly demonstrates that *Aphis acaenovinae* is holocyclic and monoecious on a herbaceous host. We have not observed sexual morphs on *Acaena* spp, which were presumably the original native host, but the same cycle most likely also applies. Both *Geum* and *Acaena* are perennial herbs in the family Rosaceae, *Geum urbanum* being of northern hemisphere origin and introduced to Australia, while *Acaena* species have a predominantly southern distribution. A native species of *Geum*, *G. talbotianum* WM Curtis, is endemic to Tasmania (Department of Primary Industries, Parks, Water and Environment, Threatened Species 2014) and would be a possible host of *A. acaenovinae*.

The Argentinian *Acaena*-feeding species *Aphis acaenaevora* is also holocyclic and monoecious (Mier Durante and Ortego 1998), as are the Australian *A. carverae* and *C. canberrae* from *Epilobium* (Hales *et al.* in press). The annual cycles of New Zealand aphidines are not known. Kim *et al.* (2011) examined a wide range of *Aphis* and related genera but were not able to conclude which type of annual cycle was ancestral: monoecy on trees,

heteroecy, or monoecy on grasses. Data so far available and those presented here indicate a Gondwanan group of holocyclic monoecious species, but more information is needed on the annual cycles of other austral indigenous aphidines.

### Acknowledgements

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## A NEW SPECIES OF *EUPHRANTA* LOEW (DIPTERA: TEPHRITIDAE: ADRAMINI) FROM SULAWESI

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### Abstract

*Euphranta wallacei* sp. n. is described from Sulawesi, Indonesia and placed in the *basalis* species group. It is the first record of the genus *Euphranta* Loew from that island.

### Introduction

The trypetine genus *Euphranta* Loew is widespread in the Oriental and Australasian regions, with two species reaching Europe and two occurring in North America. Some 108 species are currently known (Hancock and Drew 2004, David *et al.* 2013, David and Singh 2015), most of which breed in fruit and all but a few having only a single known host. Twenty-three species have been recorded previously from Indonesia (Hardy 1983, Hancock and Drew 2004, David *et al.* 2013) but, surprisingly, none from Sulawesi. Recent examination of unsorted material in the Natural History Museum, London (BMNH) revealed the first record of *Euphranta* from Sulawesi. The specimen proved to belong to a new species, which is described below.

### *Euphranta wallacei* sp. n.

(Figs 1-5)

*Type. Holotype* ♀, INDONESIA: Sulawesi, Dumoga-Bone National Park, Tangkoko, sweeping, 2.xi.1985 / Project Wallace, BM 1985-10 (Fig. 3) (in BMNH).

*Description.* Female (Figs 1-2). Length of body (excluding ovicape) 7.1 mm, of wing 6.7 mm. Head slightly higher than long; antennae dark yellow, shorter than face, third segment apically rounded, arista plumose; face pale creamy yellow, unspotted; frons pale yellow laterally, blackish brown posteromedially, pale brown anteromedially; occiput largely blackish brown. Setae black: 2 pairs frontals, widely spaced; 1 pair orbitals, closer to upper frontals than to verticals; ocellars absent; genal present.

Thorax mostly red-brown; scutum paler medially and with pale yellowish white markings as follows: postpronotal lobes, along suture from and including notopleural calli and a large prescutellar patch; propleura below postpronotal lobe and narrow dorsal band on anepisternum yellowish white; scutellum red-brown with lateral and posterior margins yellowish white. Setae black: 1 postpronotal, 2 notopleurals, 1 supra-alar, 1 postalar, 1 infra-alar, dorsocentrals just anterior to line of postalars, presutural and prescutellar acrostichals absent, 1 anepisternal, 1 anepimeral, 1 katepisternal; 2 pairs scutellars. Legs mostly yellowish white; femora with brown to red-brown medial bands; fore tibiae pale greyish brown; mid and hind tibiae dark brown to red-brown with paler apices; mid tibia with an apical black spine.





**Figs 1-2.** *Euphranta wallacei* sp. n., habitus of holotype female: (1) dorsal view; (2) lateral view. © Natural History Museum, London.



**Figs 3-5.** *Euphranta wallacei* sp. n., holotype female: (3) labels; (4) head, frontal view; (5) head, lateral view. © Natural History Museum, London.

Wing (Figs 1-2) hyaline with brown transverse markings as follows: from costa enclosing entire length of pterostigma and crossing R-M crossvein into but not crossing cell dm; broadly from costa and apical half of cell  $r_1$  to posterior margin of wing in cell m and apex of cell  $cua_1$ , leaving hyaline medial bands in cells  $r_1$  and m, the latter extending just across vein M into cell  $r_{4+5}$ ; wing apex broadly hyaline from apex of cell  $r_1$  to apex of cell m, broadest in cells  $r_{2+3}$  and  $r_{4+5}$ . Pterostigma a little more than half length of cell c; veins  $R_1$  and  $R_{4+5}$  setulose; R-M crossvein placed below apex of pterostigma, near middle of cell dm; cell bcu apically acute.

Abdomen elongate, broadest at tergite III; blackish brown except tergite II with a yellow anteromedial patch and tergite III with a yellow, longitudinal medial stripe. Oviscape yellowish on basal third, dark on apical two-thirds; a little shorter than tergites IV-VI combined; aculeus not exposed.

*Etymology.* This species, like the expedition on which the holotype was collected, is named after Alfred Russell Wallace.

*Distribution.* Known only from the type locality in northeastern Sulawesi.

## Discussion

*Euphranta wallacei* is referable to the *basalis* group as defined by Hancock and Drew (2004); it differs from all other species in the group in details of the leg, thoracic and wing patterns, particularly the very large hyaline apex of the wing. The *basalis* group is known from the Philippines and Borneo to Australia and the Solomon Islands, *E. wallacei* being the first known representative from Sulawesi. No host plants have been recorded for any member of the group.

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## AN ANNOTATED LIST OF HAWKMOTHS AND BUTTERFLIES (LEPIDOPTERA) FROM HAMMOND ISLAND, TORRES STRAIT

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### Abstract

During a visit to Hammond Island, Torres Strait, between 22 March and 4 April 2014, records were kept of adult butterflies and hawkmoths taken, observed or identified from the presence of their early stages. The list of hawkmoths totals 25 species. An additional hawkmoth species is included from records of a 1987 trip to Hammond Island by R.B. Lachlan, bringing the total to 26 species. The list of butterflies totals 49 species, comprising 7 of Papilionidae, 4 of Pieridae, 16 of Nymphalidae, 14 of Lycaenidae and 8 of Hesperidae.

### Introduction

Hammond Island lies in the southern part of Torres Strait immediately to the north-west of Thursday Island, which is the administrative centre of the Torres Strait islands. Hammond is a hilly continental island, with the highest point known locally as Command Post Hill at 143 m. It is 6.5 km long and reaches a maximum width of 3.5 km. Much of the island retains its original vegetation, a mixture of rainforest, open sclerophyll forest, some grassland and clusters of fringing mangroves. The rainforest is mostly confined to rocky hills that are made up of numerous large volcanic rocks. Very little appears to have been published on the insect fauna of Hammond Island.

We collected hawkmoths on the island at ultraviolet lights between 22 March and 4 April 2014, near the Catholic Church. The lights were run from dusk to dawn and checked for moths three to four times nightly, including pre dawn. During the day, considerable time was spent searching for eggs and larvae, but mostly without success. The only eggs or larvae found were those of *Macroglossum hirundo errans* (Walker) and *Daphnis moorei* (W.J. Macleay).

Hawkmoths have been collected previously on Hammond Island by R.B. Lachlan in January 1987 (R.B. Lachlan pers. comm.). He took only one species not recorded by us: *Macroglossum rectans* Rothschild & Jordan. Other species he collected are marked by an asterisk in Table 1 below.

During this trip, a checklist of the butterflies taken or observed, or identified from their early stages, was also compiled, with a total of 48 species recorded. The timing of this visit coincided with the very end of the wet season and hence was not deemed to be the most productive time to fully document the local butterfly fauna.

Hermann Elgner visited the island on 31 March 1910 (Moulds 1977), when apparently he took just one species, *Neopithecops zalmora lucifer* (Röber) (now *N. lucifer heria* (Fruhstorfer)). This was subsequently recorded by Waterhouse and Lyell (1914). There appear to be no other published records.

**Table 1.** List of hawkmoths and butterflies recorded from Hammond Island, Torres Strait, Queensland. Nomenclature of hawkmoths follows Kitching and Cadiou (2000) except where indicated. Nomenclature of butterflies follows Braby (2000) or Page and Treadaway (2013). \* = also recorded by R.B. Lachlan in January 1987.

| Species list  | Comments  |
|---|---|
| <b>HAWKMOTHS</b>  |   |
| Subfamily SPHINGINAE Latreille, [1802]                        |   |
| Tribe Acherontiini Boisduval, [1875]                          |   |
| <i>Agrius convolvuli</i> (Linnaeus, 1758)                     | Common  |
| Tribe Sphingini Latreille, [1802]                             |   |
| <i>Cerbernoton rubescens severina</i> (Miskin, 1891)          | Infrequent. <i>Meganoton rubescens severina</i> was recently transferred to genus <i>Cerbernoton</i> by Zolotuhin and Ryabov (2012) |
| <i>Psilogramma nebulosa</i> (Butler, 1876)*                   | Common  |
| <i>Psilogramma papuensis</i> Brechlin, 2001*                  | Infrequent  |
| Subfamily MACROGLOSSINAE Harris, 1839                         |   |
| Tribe Macroglossini Harris, 1839                              |   |
| <i>Acosmeryx</i> nr <i>anceus</i> (Herrich-Schäffer, [1869])* | Common. Status subject to revision by Moulds, Tuttle and Lane, in prep.   |
| <i>Acosmeryx miskinii</i> (Murray, 1873)                      | Scarce  |
| <i>Daphnis moorei</i> (W.J. Macleay, 1866)                    | Infrequent. <i>D. hypothous moorei</i> was recently raised to species status by Eitschberger and Melichar (2010)                    |
| <i>Daphnis placida placida</i> (Walker, 1856)*                | Frequent  |
| <i>Gnathothlibus eras</i> (Boisduval, 1832) *                 | Common  |
| <i>Macroglossum hirundo errans</i> (Walker, 1856)             | Common. Eggs and larvae found on <i>Pogonolobus</i> (= <i>Coelospermum</i> ) <i>reticulatus</i>                                     |
| <i>Macroglossum micacea micacea</i> (Walker, 1856)            | Infrequent  |
| <i>Macroglossum prometheus lineata</i> (T.P. Lucas, 1891)     | Infrequent  |
| <i>Macroglossum rectans</i> Rothschild & Jordan, 1903*        | Infrequent. Taken only by R.B. Lachlan in January, 1987   |
| <i>Nephele hespera</i> (Fabricius, 1775)                      | Scarce  |
| <i>Nephele subvaria</i> (Walker, 1856)                        | Infrequent  |

| Species list   | Comments  |
|--|---|
| Tribe Dilophonotini Burmeister, 1878                         |   |
| <i>Hippotion boerhaviae</i> (Fabricius, 1775)                | Frequent  |
| <i>Hippotion brennus</i> (Stoll, 1782)*                      | Infrequent  |
| <i>Hippotion rosetta</i> (Swinhoe, 1892)*                    | Frequent  |
| <i>Hippotion velox</i> (Fabricius, 1793)                     | Infrequent  |
| <i>Theretra celata celata</i> (Butler, 1877)                 | Infrequent  |
| <i>Theretra indistincta indistincta</i> (Butler, 1877)*      | Infrequent  |
| <i>Theretra inornata</i> (Walker, [1865])                    | Frequent  |
| <i>Theretra latreillii latreillii</i> (W.S. Macleay, 1826)*  | Common  |
| <i>Theretra oldenlandiae oldenlandiae</i> (Fabricius, 1775)* | Infrequent  |
| <i>Theretra silhetensis intersecta</i> (Butler, [1876])*     | Common  |
| <i>Theretra tryoni</i> (Miskin, 1891)                        | Infrequent  |
| <b>BUTTERFLIES</b>   |   |
| Family PAPILIONIDAE  |   |
| <i>Graphium choredon</i> (C. & R. Felder)                    | Reasonably abundant; adults often encountered drinking moisture from ground puddles |
| <i>Graphium macfarlanei macfarlanei</i> (Butler)             | Two adults observed   |
| <i>Papilio aegaeus aegaeus</i> Donovan                       | Common, widespread  |
| <i>Papilio fuscus indicatus</i> Butler                       | Often observed feeding on flowers of <i>Bougainvillea</i>                           |
| <i>Cressida cressida cressida</i> (Fabricius)                | Common, widespread  |
| <i>Pachliopta polydorus queenslandicus</i> (Rothschild)      | Common, widespread  |
| <i>Ornithoptera priamus poseidon</i> (Doubleday)             | Several observed  |
| Family PIERIDAE  |   |
| <i>Catopsilia pomona</i> (Fabricius)                         | Adults common; eggs and larvae observed on <i>Cassia</i> sp.                        |
| <i>Eurema herla</i> (W.S. Macleay)                           | Common in open grassland  |
| <i>Eurema hecabe hecabe</i> (Linnaeus)                       | Common in open grassland  |
| <i>Elodina queenslandica queenslandica</i> De Baar & Hancock | Limited to areas adjacent to its <i>Capparis</i> food plant                         |



| Species list  | Comments  |
|---|---|
| Family NYMPHALIDAE  |   |
| <i>Mycalesis terminus terminus</i> (Fabricus)               | Common, widespread  |
| <i>Mycalesis perseus perseus</i> (Fabricus)                 | Common, widespread  |
| <i>Ypthima arctous arctous</i> (Fabricus)                   | Several observed  |
| <i>Melanitis leda bankia</i> (Fabricus)                     | Common, widespread  |
| <i>Pantoporia consimilis consimilis</i> (Boisduval)         | Common along rainforest margins   |
| <i>Phaedyma shepherdii shepherdii</i> (Moore)               | Common along rainforest margins   |
| <i>Doleschallia bisaltide australis</i> C. & R. Felder      | Common along rainforest margins; also adults feeding on <i>Eucalyptus</i> blossom |
| <i>Hypolimnias alimena lamina</i> Fruhstorfer               | Common along rainforest margins   |
| <i>Hypolimnias bolina nerina</i> (Fabricus)                 | Common, widespread  |
| <i>Yoma sabina parva</i> (Butler)                           | Common along rainforest margins   |
| <i>Junonia orithya albicincta</i> Butler                    | Common, widespread  |
| <i>Junonia villida calybe</i> (Godart)                      | Common, widespread  |
| <i>Junonia hedonia zelima</i> (Fabricus)                    | Common, widespread  |
| <i>Danaus chrysippus petilia</i> (Stoll)                    | Common, widespread  |
| <i>Danaus affinis affinis</i> (Fabricus)                    | Common, widespread  |
| <i>Euploea core corinna</i> (W.S. Macleay)                  | Common  |
| Family LYCAENIDAE   |   |
| <i>Hypochrysops narcissus sabirius</i> (Fruhstorfer)        | Common along mangrove/rainforest interface margins                                |
| <i>Hypochrysops apelles apelles</i> (Fabricus)              | Common along mangrove margins   |
| <i>Arhopala centaurus centaurus</i> (Fabricus)              | Common along rainforest margins   |
| <i>Arhopala madytus</i> Fruhstorfer                         | Locally common  |
| <i>Arhopala micale amytis</i> (Hewitson)                    | Common, widespread  |
| <i>Hypolycaena phorbas phorbas</i> (Fabricus)               | Common, widespread  |
| <i>Rapala varuna simsoni</i> (Miskin)                       | Several observed  |
| <i>Anthene seltuttus affinis</i> (Waterhouse & R.E. Turner) | Locally common  |
| <i>Anthene lycaenoides godeffroyi</i> (Semper)              | Several observed  |
| <i>Candalides erinus erinus</i> (Fabricus)                  | Common, widespread  |

| Species list   | Comments   |
|--|--|
| <i>Psychonotis caelius taygetus</i> (C. & R. Felder) | Common, widespread   |
| <i>Neopithecops lucifer heria</i> (Fruhstorfer)      | Collected once by H. Elgner in March, 1910                               |
| <i>Euchrysops cnejus cnidus</i> Waterhouse & Lyell   | Common in open grassland   |
| <i>Famegana alsulus alsulus</i> (Herrich-Schäffer)   | Several observed   |
| Family HESPERIIDAE                                   |  |
| <i>Badamia exclamationis</i> (Fabricus)              | Common along rainforest margins  |
| <i>Hasora hurama hurama</i> (Butler)                 | Larval shelters observed on <i>Derris trifoliata</i> ; no adults sighted |
| <i>Hasora chromus chromus</i> (Cramer)               | Several observed   |
| <i>Toxidia thyrrhus</i> Mabilie                      | Infrequently observed  |
| <i>Suniana sunias rectivitta</i> (Mabilie)           | Common, widespread   |
| <i>Telicota augias</i> (Linnaeus)                    | Common along rainforest margins  |
| <i>Pelopidas lyelli lyelli</i> (Rothschild)          | Common, widespread   |
| <i>Pelopidas agna dingo</i> Evans                    | Common, widespread   |

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## FURTHER RECORDS OF *DELIAS LARA* (BOISDUVAL, 1836) (LEPIDOPTERA: PIERIDAE) FROM AUSTRALIA

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### Abstract

New records of *Delias lara* (Boisduval, 1836) from the Torres Strait, northern Queensland, are presented and the species is confirmed as resident within Australian limits on Moa Island.

### Introduction

Davenport and van Mastrigt (2008), in their revision of *Delias mysis* (Fabricius, 1775), designated *Delias mysis onca* (Fruhstorfer, 1910) as a synonym of *Delias lara* (Boisduval, 1836). It is one of four similarly patterned taxa recorded from Australia, including typical *D. mysis mysis* in eastern Queensland, *D. aestiva aestiva* Butler, 1897 in the Northern Territory and *D. aestiva smithersi* Daniels, 2012 from Karumba to Weipa on the Gulf of Carpentaria (Braby 2012, Daniels 2012, Braby 2014).



**Figs 1-4.** *Delias lara* adults from Moa Island, Torres Strait: (1) male upperside; (2) male underside; (3) female upperside; (4) female underside. All in CGM collection.

## Discussion

Within Australian limits, *D. lara* was known previously from only three specimens. One male and one female were collected by the missionary J.W. Schomberg on Moa (= Banks) Island; the specimens are undated but would have been collected between 1921 and 1936, the period in which he was resident on the island (Schomberg 2008). Lachlan (1988) collected a second female, on Dauan Island, in January 1987.

Braby (2012) gave a detailed discussion of the relationship between *Delias aestiva*, *D. mysis* and *D. lara* but, because he saw only the three specimens of *D. lara* mentioned above, he concluded: 'It remains to be established whether the species is established (resident) in the northern and central Torres Strait islands or whether the few specimens represent vagrants that have dispersed south from Papua New Guinea'.

The present authors are aware of eight further specimens of *D. lara* from Australia: 2 ♂♂, 1 ♀, labelled 'Eet Hill, Moa Is., Torres Strait, Qld, 9 July 1977, C.G. Miller' (in C.G. Miller collection); 3 ♂♂, 'Eet Hill vicinity, Moa Is., Torres Strait, Qld, 9-13 July 1977, G. Monteith and D. Cook' (in Queensland Museum, Brisbane); 1 ♂, 'Moa Is, Torres Strait, Qld, 2 July 1993, S.J. Johnson' (in Museum of Tropical Queensland, Townsville); 1 ♀, '09°25'13.00"S 142°32'05.16"E, Mt Cornwallis, Dauan Is, Torres St, Qld, 7-8 Mar 2012, S.J. & I.R. Johnson' (in Museum of Tropical Queensland).

The July 1977 specimens were collected at the head of Neri Creek (10.161°S, 142.300°E), where it enters the rainforest-filled valley between Eet Hill and Banks Peak in the NE sector of Moa Island. This site is in the centre of the island, far from coastal mangroves favoured at other places by the butterfly's close relatives *D. aestiva aestiva* and *D. a. smithersi* (Braby 2012, Daniels 2012). Moa is the largest island (diameter 16 km) in the central Torres Strait and has the highest mountains (up to 350 m altitude) of all Torres Strait islands. The rainforest which covers these mountains and valleys is the most diverse in Torres Strait and benefits from enhanced rainfall generated by the mountains. These factors all combine to give Moa Island a better potential to sustain a resident population of *D. lara* than enjoyed by any other island in Torres Strait.

All six specimens collected in July 1977 were in very fresh condition. Several others were observed flying at the margins of lowland rainforest and settling frequently. The presence of numerous freshly emerged adults indicates that a breeding population is established on Moa Island. Moa is 100 km from the New Guinea mainland so to get a large group of vagrants in good condition would be very unusual. The resident vs vagrant status of the species on Dauan Island, which is very small (1.75 km diameter), is only 10 km from the Papua New Guinea mainland and has little quality rainforest, remains uncertain.

For a general account of Moa Island butterflies see Valentine and Johnson (1993).

### **Acknowledgements**

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## ADDITIONAL RECORDS OF PREDATION ON BUTTERFLIES BY BREEDING RAINBOWBIRDS (*MEROPS ORNATUS*: MEROPIDAE)

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This note lists butterfly prey taken during 2013 and 2014 by Rainbowbirds breeding beside Currimundi Lake, southern Queensland, as previously documented for 2012 (Orr 2013). In both cases only a single male and female bird were present, with the female accounting for most prey taken to the nest.

In total, 133 individual butterflies representing 34 species were recorded photographically. Three prey items were listed as 'unknown butterfly' and are not counted. Among the most noteworthy records are *Graphium macleayanum* and *Jalmenus evagoras*, neither recorded previously in the area and captured between 50-100 m altitude, where they were invisible to the human observer. It is likely that these species were engaged in long-distance dispersal. *Belenois java* was taken just once, despite being very abundant at times during both years, suggesting low palatability. In addition to the butterflies, 25 moths were taken, notably a single *Cephonodes hylas* and 18 individuals of *Spodoptera* sp., 17 taken in a single run. As in 2012, Lepidoptera represented numerically less than 10% of prey taken.

Below are listed the butterfly species with their totals taken during 2013 and 2014 respectively. Included are items eaten by the captor, nuptial gifts and items fed to nestlings. Species also recorded in 2012 are indicated by an asterisk. Order of species follows Orr and Kitching (2010). No *Vanessa itea* were recorded in 2013 or 2014.

*Hasora discolor* (0, 1), *Hasora khoda* (1, 0), \**Trapezites symmommus* (3, 2), *Toxidia peron* (3, 0), *Mesodina halyzia* (3, 2), \**Ocybadistes ?walkeri* (1, 0), \**Telicota ?colon* (3, 1), \**Cephrenes augiades* (2, 8), *Parnara amalia* (1, 0), *Protographium leosthenes* (1, 0), \**Graphium eurypylus* (4, 0), \**Graphium choredon* [formerly *sarpedon*] (2, 0), *Graphium macleayanum* (1, 2), \**Catopsilia pomona* (2, 10), *Catopsilia pyranthe* (1, 0), *Eurema hecabe* (1, 0), *Eurema* sp. (3, 0), *Pieris rapae* (1, 0), *Appias paulina* (2, 1), *Cepora perimale* (0, 1), *Belenois java* (1, 0), *Melanitis leda* (1, 0), \**Junonia villida* (6, 1), \**Vanessa itea* (0, 0), *Vanessa kershawi* (18, 4), *Hypolimnas bolina* (1, 1), *Hypochrysops delicia* (3, 0), \**Ogyris zosine* (2, 5), *Jalmenus evagoras* (0, 1), *Rapala varuna* (2, 2), *Deudorix diovis* (4, 4), *Candalides ?absimilis* (3, 0), *Candalides ?hyacinthinus* (1, 0), \**Nacaduba berenice* (3, 0), \**Theclines thes miskini* (2, 5).

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# A NEW SUBGENUS FOR SIX INDO-AUSTRALIAN SPECIES OF *BACTROCERA* MACQUART (DIPTERA: TEPHRITIDAE: DACINAE) AND SUBGENERIC TRANSFER OF FOUR OTHER SPECIES

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## Abstract

*Calodacus* subgen. n. is proposed to include six species of Asian and Australasian *Bactrocera* Macquart species formerly included in subgenus *Gymnodacus* Munro, viz: *B. (C.) calophylli* (Perkins & May) [type species], *B. (C.) continua* (Bezzi), *B. (C.) hastigerina* (Hardy), *B. (C.) kuniyoshii* (Shiraki), *B. (C.) symplocos* Drew & Romig and *B. (C.) tillyardi* (Perkins). An additional Papua New Guinea species, *B. petila* Drew, is transferred from subgenus *Gymnodacus* to subgenus *Bactrocera*, together with three SE Asian species, *B. digressa* Radhakrishnan, *B. fastigata* Tsuruta & White and *B. rutengiae* Drew & Romig, currently included in the Afrotropical subgenus *Daculus* Speiser or its synonym *Afrodacus* Bezzi.

## Introduction

The subgeneric classification of the large fruit fly genus *Bactrocera* Macquart has undergone much modification in recent years. Drew (1989) and Drew and Romig (2013) effectively placed most Australian-Oceanian and Southeast Asian species into a currently acceptable arrangement, although a few uncertainties remained. White and Evenhuis (1999) and White (2006) noted that Indo-Australian species currently included in subgenus *Gymnodacus* Munro differed significantly from typical African species, particularly in the deeper emargination to abdominal sternum V, the presence of yellow colouration on the anatergite and the short extension to wing cell bcu. Whereas the Afrotropical subgenera *Gymnodacus* and *Daculus* Speiser (including its synonym *Afrodacus* Bezzi) are referable to the *Melanodacus* group of subgenera (Drew and Hancock 1999), Indo-Australian species referred to these subgenera are typical of the *Bactrocera* group of subgenera, characterised by the combination of a short surstylus lobe and deep emargination to sternum V. Accordingly, a new subgenus is proposed below to accommodate six of the Australasian and SE Asian species currently included in *Gymnodacus* (Drew 1989, Drew and Romig 2013). The placement of an additional Papua New Guinea species in *Gymnodacus* and three SE Asian species in *Daculus* and *Afrodacus* is also reassessed.

## *Bactrocera (Calodacus)* subgen. n.

Type species *Asiadacus calophylli* Perkins & May, by present designation.

**Definition.** Posterior lobe of male surstylus short; abdominal sternum V of male deeply concave on posterior margin; pecten of cilia absent from tergum III of male; postpronotal setae absent; supra-alar setae present except in *B. continua* (Hardy); prescutellar acrostichal setae present except in *B. hastigerina* (Hardy); one pair of scutellar setae; wing cell bcu with extension short; bulla in male wing absent; anatergite and katatergite both largely yellow; shining spots (ceromata) on abdominal tergum V present.

*Etymology.* The name is derived from that of the type-species: *calo-* plus the suffix *-dacus*. Alphabetically, it follows immediately after its presumed sister-subgenus, *Bulladacus* Drew & Hancock.

*Response to male lures.* None known for any of the included species.

*Comments.* *Calodacus* appears to be closely related to subgenus *Bulladacus*, as noted by White and Evenhuis (1999), with both having comparatively short antennae, a short extension to wing cell *bcu* and neither responding to known lures; it differs in the presence of the abdominal shining spots (ceromata) on tergum V. Typical *Bulladacus* also differs in the presence of the bulla on the male wing and presence of the pecten on abdominal tergum III, although at least two Papua New Guinea species (*B. aceraglans* White & Evenhuis, 1999 and *B. sp.* near *aceraglans* White & Evenhuis, 1999) lack both these characters (White and Evenhuis 1999). However, they also lack the ceromata and are therefore provisionally retained in the latter subgenus. Interestingly, *B. aceraglans* has a patch of long cilia where the male bulla usually occurs and a *Bulladacus*-like abdomen, adding further support to their current placement.

*Included species.* Six species are referred to subgenus *Calodacus*: *B. (C.) calophylli* (Perkins & May, 1949) from southern Thailand and the Andaman Islands to Australia, Solomon Islands and Vanuatu; *B. (C.) continua* (Bezzi, 1919) from the Philippines; *B. (C.) hastigerina* (Hardy, 1954) from Papua New Guinea (New Britain) and Solomon Islands (Guadalcanal); *B. (C.) kuniyoshii* (Shiraki, 1968) from Japan (Ryukyu Islands); *B. (C.) symplocos* Drew & Romig, 2013 from Thailand; and *B. (C.) tillyardi* (Perkins, 1938 (= *absona* Hering, 1941) from Burma and Peninsula Malaysia [all transferred from subgenus *Gymnodacus*]. For illustrations and further morphological details see Drew (1989) and Drew and Romig (2001, 2013).

*Host plants.* Recorded host plants include *Calophyllum inophyllum* (Clusiaceae) [*B. calophylli*], *Spondias cytherea* (Anacardiaceae) [*B. hastigerina*], *Symplocos cochinchinensis* (Symplocaceae), *Sapium baccatum* (Euphorbiaceae) and *Spondias pinnata* (Anacardiaceae) [*B. symplocos*] (Drew and Romig 2001, 2013).

### Key to species of subgenus *Calodacus*

- 1 Scutum black without postsutural yellow vittae; postpronotal lobes yellow with narrow black anterior and inner margins; scutellum with a broad black basal band; wing with costal band broadly interrupted in cell  $r_1$  and narrow dark bands present along R-M and DM-Cu crossveins (Burma and West Malaysia) ..... *B. (C.) tillyardi* (Perkins, 1938)
- Scutum black or pale but with a pair of distinct postsutural lateral yellow vittae; postpronotal lobes entirely yellow; scutellum with only a narrow dark basal band; wing with costal band not interrupted in cell  $r_1$  and without dark bands along R-M and DM-Cu crossveins ..... 2

- 2 Scutum orange-brown; postpronotal lobes connected to postsutural vittae by presutural lateral yellow vittae; postsutural lateral yellow vittae triangular, narrowing posteriorly; anepisternal yellow stripe reaching postpronotal lobe anteriorly; wing with costal cells bc and c densely microtrichose (Philippines) ..... *B. (C.) continua* (Bezzi, 1919)
- Scutum black or red-brown with broad dark markings; presutural lateral yellow vittae absent; postsutural lateral yellow vittae parallel-sided, not distinctly narrowing posteriorly; anepisternal yellow stripe not reaching postpronotal lobe anteriorly; wing with costal cells bc and c densely microtrichose only in outer half of cell c ..... 3
- 3 Scutum with postsutural lateral yellow vittae narrow and not reaching intra-alar setae; legs fulvous except fore and hind tibiae pale fuscous .... 4
- Scutum black with postsutural lateral yellow vittae broad and enclosing intra-alar setae; legs with all tibiae and apices of all femora fuscous to dark fuscous ..... 5
- 4 Scutum red-brown with broad dark markings; costal cells bc and c pale fuscous; prescutellar setae absent; abdomen with indistinct dark markings across base of tergum III and narrow fuscous medial vittae on terga III-V not forming a distinct, continuous stripe (Papua New Guinea: New Britain and Solomon Islands: Guadalcanal) ..... *B. (C.) hastigerina* (Hardy, 1954)
- Scutum black; costal cells bc and c with a pale fuscous tint; prescutellar setae present; abdomen with a distinct black band across base of tergum III and a distinct black medial vitta on terga III-V (India: Andaman and Nicobar Islands, southern Thailand: Songkhla, West Malaysia, Singapore, Australia: NE Queensland, Solomon Islands: Guadalcanal and Vanuatu: Espiritu Santo) ..... *B. (C.) calophylli* (Perkins & May, 1949)
- 5 Facial spots small and elongate-oval; all femora with broad fuscous apices; abdominal terga III-V with lateral margins at most indistinctly darkened and with a broad medial vitta (Japan: Ryukyu Islands) .....  
..... *B. (C.) kuniyoshii* (Shiraki, 1968)
- Facial spots large and circular; fore femora with an elongate subapical fuscous spot; mid and hind femora with narrow fuscous apices; abdominal terga III-V with broad black lateral margins and with a narrow medial vitta (Thailand) ..... *B. (C.) symplocos* Drew & Romig, 2013

### Other Indo-Australian ‘*Gymnodacus*’ species

The Papua New Guinea species *Bactrocera petila* Drew, 1989 was originally placed in subgenus *Gymnodacus* by Drew (1989) but differs from those included here in *Calodacus* in having comparatively longer antennae, an elongate-oval abdomen and an elongate cell bcu extension coupled with a broad anal stripe that meets vein CuA<sub>1</sub> near the apex of cell bm; it also

responds to cue-lure (Drew 1989). Fitting in neither typical *Gymnodacus* nor *Calodacus*, it is regarded here as an aberrant species of subgenus *Bactrocera*, characterised by the lack of the male abdominal pecten on tergum III.

**Indo-Australian ‘*Daculus*’ and ‘*Afrodacus*’ species**

Subgenus *Afrodacus* was placed as a junior synonym of *Daculus* by Copeland *et al.* (2004) and restricted to the Afrotropical Region (except for its type-species *B. (D.) oleae* (Rossi, 1790), which extends into Europe and SW Asia). The Indo-Australian species *B. brunnea* (Perkins & May, 1949), *B. fastigata* Tsuruta & White, 2001, *B. grandistylus* Drew & Hancock, 1995, *B. hypomelaina* Drew, 1989, *B. jarvisi* (Tryon, 1927), *B. minuta* (Drew, 1971) and *B. ochracea* Drew, 1989 were all transferred to subgenus *Bactrocera* by Copeland *et al.* (2004) and this placement was followed for the Australian species *B. brunnea* and *B. jarvisi* by Hancock (2013). The Indian-Sri Lankan species *B. fastigata* was retained in ‘*Afrodacus*’ by Drew and Romig (2013), who also included, with considerable reservation, two additional species in subgenus *Daculus*, viz. *B. digressa* Radhakrishnan, 1999 (= *yercaudiae* Drew, 2002; David and Ramani 2011) and *B. rutengiae* Drew & Romig, 2013. These three species are regarded here as aberrant species of subgenus *Bactrocera*, characterised by the absence of supra-alar (and often also prescutellar acrostichal) setae.

The 10 subgeneric changes proposed here are listed in Table 1.

**Table 1.** Subgeneric placement of Indo-Australian *Bactrocera* species here removed from subgenera *Gymnodacus*, *Daculus* and *Afrodacus*.

| As currently placed                               | Revised placement                             |
|---|---|
| <b>Australian-Oceanian taxa</b> <sup>1</sup>      |   |
| <i>B. (Gymnodacus) calophylli</i> (Perkins & May) | <i>B. (Calodacus) calophylli</i>              |
| <i>B. (Gymnodacus) hastigerina</i> (Hardy)        | <i>B. (Calodacus) hastigerina</i>             |
| <i>B. (Gymnodacus) petila</i> Drew                | <i>B. (Bactrocera) petila</i>                 |
| <b>SE Asian taxa</b> <sup>2</sup>                 |   |
| <i>B. (Afrodacus) fastigata</i> Tsuruta & White   | <i>B. (Bactrocera) fastigata</i> <sup>3</sup> |
| <i>B. (Daculus) digressa</i> Radhakrishnan        | <i>B. (Bactrocera) digressa</i> <sup>4</sup>  |
| <i>B. (Daculus) rutengiae</i> Drew & Romig        | <i>B. (Bactrocera) rutengiae</i>              |
| <i>B. (Gymnodacus) calophylli</i> (Perkins & May) | <i>B. (Calodacus) calophylli</i>              |
| <i>B. (Gymnodacus) continua</i> (Bezzi)           | <i>B. (Calodacus) continua</i>                |
| <i>B. (Gymnodacus) kuniyoshii</i> (Shiraki)       | <i>B. (Calodacus) kuniyoshii</i>              |
| <i>B. (Gymnodacus) symplocos</i> Drew & Romig     | <i>B. (Calodacus) symplocos</i>               |
| <i>B. (Gymnodacus) tillyardi</i> (Perkins)        | <i>B. (Calodacus) tillyardi</i>               |

<sup>1</sup> As treated by Drew (1989). <sup>2</sup> As treated by Drew and Romig (2013), with *B. (G.) absona* (Hering) included as a synonym of *B. tillyardi*. <sup>3</sup> As originally proposed by Copeland *et al.* (2004). <sup>4</sup> As placed originally and by David and Ramani (2011).

***Bactrocera decurtans* and *B. murrayi***

Two Australian species, *B. decurtans* (May, 1965) and *B. murrayi* (Perkins, 1939), would also fit the concept of ‘*Daculus*’ as used by Drew and Romig (2013). Provisionally included in subgenus *Polistomimetes* Enderlein (now placed as a synonym of subgenus *Tetradacus* Miyake) by Drew (1989), these two species were placed in subgenus *Bactrocera* by Hancock *et al.* (2000) and Hancock (2013), as originally suggested by Drew (1989).

**Relationships and biogeography of *Calodacus* species**

The six species of *Calodacus* form two species pairs and two isolated taxa. The two most easterly occurring species, *B. calophylli* and *B. hastigerina*, share the characters of narrow postsutural lateral yellow vittae that do not reach the intra-alar setae and pale legs with only the fore- and hind tibiae darkened. Although *B. calophylli* is widespread from the Andaman Islands and southern peninsular Thailand to Australia, the Solomon Islands and Vanuatu, *B. hastigerina* appears to be restricted to the Bismarck and Solomon Islands. The extensive distribution of *B. calophylli* likely results from its use of the widespread coastal tree *Calophyllum inophyllum* as its host.

The two East and Southeast Asian species *B. kuniyoshii* and *B. symplocos* have broad postsutural lateral yellow vittae that enclose the intra-alar setae and legs with all tibiae and femoral apices darkened. These two species are allopatric, known from the Ryukyu Islands and Thailand respectively.

The Philippine species *B. continua*, with its distinctive pre- and postsutural lateral yellow vittae and broad anepisternal stripe, is known from the islands of Luzon and Batbatan. The broad postsutural vittae and dark apices to all femora suggest a relationship with the *kuniyoshii-symplocos* pair and its distribution largely supports this association.

The Southeast Asian *B. tillyardi*, with its distinctive wing and scutellar patterns and lack of postsutural lateral yellow vittae, is the most westerly recorded of the species, known from northern Burma and Peninsular Malaysia. In overall appearance it bears a striking resemblance to the Papua New Guinea species *B. (Trypetidacus) invisitata* Drew (which also lacks the pecten of cilia on abdominal tergum III in males), but that species lacks both supra-alar and prescutellar setae, has only a narrow basal black band on the scutellum, the anatergite black, costal band present in wing cell  $r_1$  and a very short (rudimentary) cell  $bcu$  extension; it also responds to methyl eugenol (Drew 1989). *Bactrocera tillyardi* cannot be confidently associated with any other species, although its distribution also suggests a relationship with the *kuniyoshii-symplocos* pair.

On present evidence it is not possible to determine a centre of origin for the subgenus, which could be either Southeast Asia or the Australian Region. More information on distributions is needed and there is a high probability that other species await discovery: their lack of response to known lures



means that they are very poorly represented in collections. However, an apparent relationship with species in subgenus *Bulladacus* and possibly also with *B. (Queenslandacus) exigua* (May), the only other taxa with a deeply concave posterior margin to sternum V, short cell bcu extension, anatergite and katatergite largely yellow and no response to known lures, suggests that the Australian Region is a likely option.

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## THE LIFE HISTORY OF *CANDALIDES INSANEA* MÜLLER, 2013 (LEPIDOPTERA: LYCAENIDAE) AND DESCRIPTION OF THE FEMALE

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### Abstract

The early stages and adult female of *Candalides insanea* Müller, from the Bismarck Archipelago, Papua New Guinea, are described and figured. *Corandrium polyanthem* (Laut. & K.Sch.) Mez. (Primulaceae) is tentatively recorded as the larval food plant.

### Introduction

*Candalides insanea* Müller, 2013, previously known only from the male holotype, is a recently described species that appears to be endemic to the island of New Britain, Papua New Guinea. Currently, the species is only known from the Whiteman Range, West New Britain Province, where other distinctive butterfly taxa have been discovered in recent times (Müller and Wills 2013, Müller 2014a). It is the only species of *Candalides* Hübner known to occur in the Bismarck Archipelago.

Müller (2013) placed *C. insanea* in the ‘*absimilis* group’ of *Candalides*, formerly within *Holochila* Felder, recognised by Tite (1963) and Braby (2000). This is the largest species-group of the genus, with representatives in mainland New Guinea and satellite islands and with four species in northern and eastern Australia (Parsons 1998, Braby 2000, 2008). Members of the *absimilis* group appear to fall into two further divisions, in which one has male genitalia with relatively simple valva, while the other has valvae which bear long apical appendages (Müller 2014b).

Müller (2013) considered that *C. insanea* has no close relatives, based on its distinctive facies, but compared the taxon with *C. pruina* Druce, 1904, *C. neurapacuna* Bethune-Baker, 1908 and *C. silicea* (Grose-Smith, 1894) (see also Müller 2014b), all of which possess long apical processes to the valva of the male genitalia. The male genitalia of *C. insanea* are particularly large and the valvae are adorned with exaggerated, blade-like processes.

*C. insanea* is an exquisite species with a unique iridescent green upperside and broad, straight forewing border that is oblique to the termen. The taxon has long forewings, giving it a distinctive shape. It has the most boldly patterned underside in the genus and the underside ground colour is also atypical of the genus, being light grey with a slight pink hue.

Voucher specimens, all collected within 5 km of the type locality at 6°0'S 150°35'E, between November 2011 and December 2014, have been deposited in the Australian Museum (Sydney), Australian National Insect Collection (Canberra), Natural History Museum (London) and in the reference collections of the author and that of Ed Petrie.

***Candalides insanea* Müller**

(Figs 1-4)

*Description of female* (Figs 3-4). Measurements (mm): forewing length mean 20 (n = 20); antenna length mean 12 (n = 20). Head dark brown-black; labial palpus light white-grey, eye ringed narrowly with white-grey; antennae black, ringed weakly with grey ventrally. Thorax dark grey-brown above, beneath white-grey. Abdomen dark brown-black above, white-grey beneath.

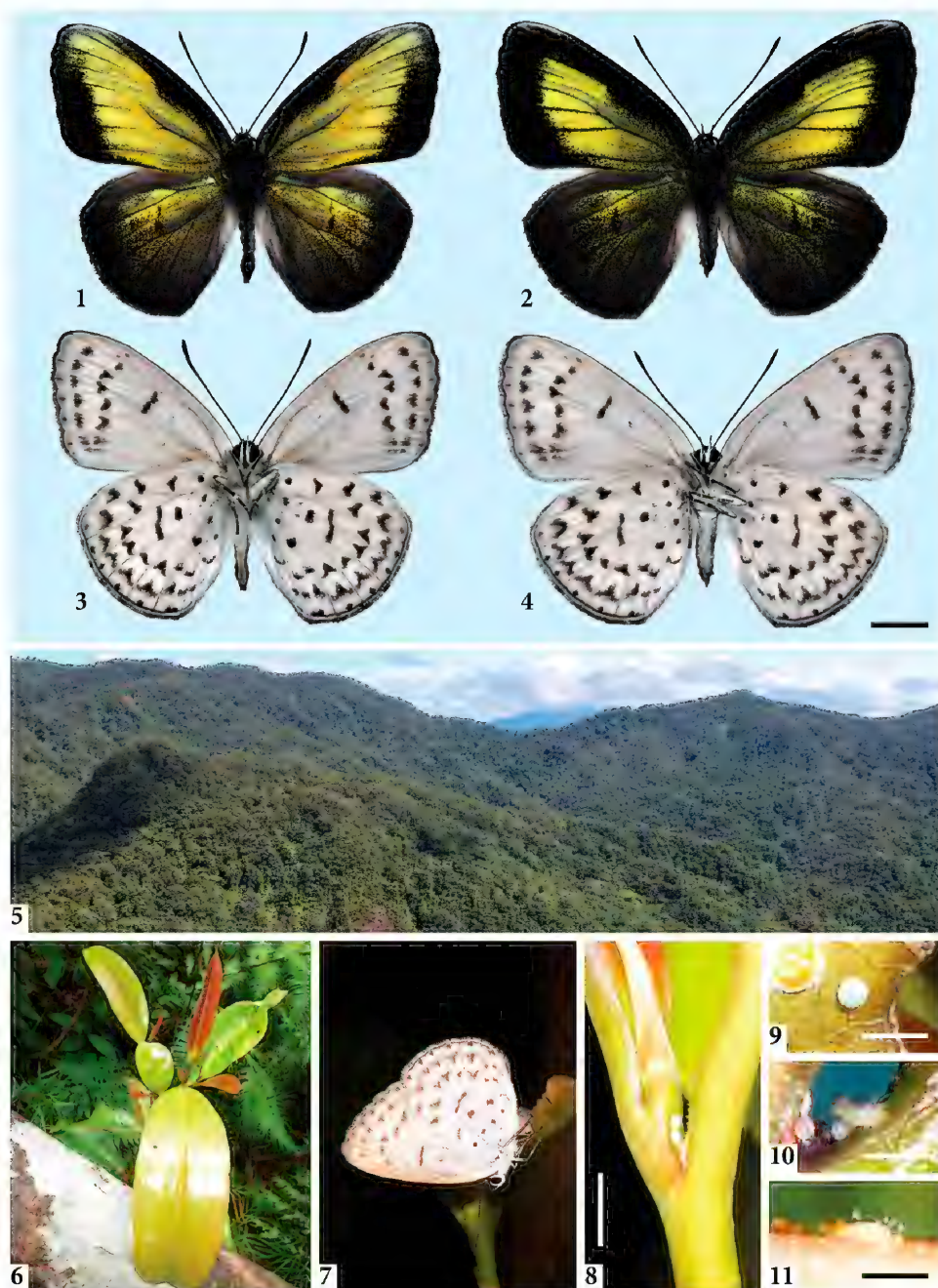
Forewing with termen slightly convex, subtly serrated near apex; upperside ground colour iridescent bronze-green, black along veins; costa and termen broadly dark brown-black, extending narrowly into cell, costa near apex narrowly grey-pink, cilia brown-black and white-grey at tornus and along inner margin; underside background colour white-grey with subtle pink hue, termen narrowly black, a row of diffuse black terminal spots (*ca* 1 mm in size) between veins, a second row of subterminal spots of similar size and colouring between veins 1b and 7 that are more clearly defined towards termen, a postmedian band of triangular dark brown-black spots (*ca* 1 mm in size but decreasing in size towards costa) between veins 1b and 9, offset at vein 4, the postmedian and subterminal bands converge between veins 1b and 2, a median black bar in discocellular region at end of cell between veins 4 and 6, cilia light grey and dark grey at vein ends.

Hind wing rounded; upperside ground colour bronze-green, heavily dusted with dark brown, also dark brown along veins and discocellulars, costa, termen and inner margin broadly dark brown, between inner margin and vein 1b medium brown grading to light grey at base, cilia dark brown-black close to termen and light grey elsewhere; underside background colour white-grey with subtle pink hue, termen narrowly black, a row of well-defined black terminal spots (approximately 0.7 mm in size) between veins from vein 1b to 7, a second row of triangular subterminal spots (up to 1.5 mm in size) of similar colouring between veins 2 and 8, a postmedian band of triangular black spots approximately 1 mm in size between veins 2 and 8, a sub-basal row of four irregular dark brown-black spots approximately 0.7 mm in size, a basal row of four well defined circular black spots approximately 0.5 mm in size, a median dark brown-black bar approximately 0.3 mm wide in discocellular region at end of cell between veins 4 and 6, cilia light grey and dark grey at vein ends.

*Early stages*

*Food plant.* *Conandrium polyanthum* (Laut. & K.Sch.) Mez. (Primulaceae). The plant (Fig. 6) has been tentatively identified owing to the absence of inflorescence material for the assessment.

*Egg* (Figs 8-9). Approximately 1.0 mm in diameter, 0.5 mm high; intricately pitted; white (pale blue-green when first laid). Duration four to five days.



**Figs 1-11.** (1-4) *Candalides insanea* adults: (1) male upperside; (2) female upperside; (3) male underside; (4) female underside. (5) Typical habitat of *C. insanea*, Whiteman Range. (6) *C. insanea* larval food plant. (7) *C. insanea* female ovipositing. (8) *C. insanea* eggs. (9) *C. insanea* egg. (10) *C. insanea* first instar larva emerging. (11) *C. insanea* first instar larva feeding. Scale bar = 5 mm (Figs 1-4, 8); 2 mm (Figs 9-11).

*First instar larva* (Figs 10-11). 1.5-2.0 mm long, 0.5 mm wide; head light orange-brown; body pale green, with narrow pink dorsal stripe; series of long dorsolateral and ventrolateral translucent setae arranged in pairs.

*Second instar larva* (Figs 12-13). 2.5-3.5 mm long, 1.0 mm wide; head light orange-brown; abdominal segment 12 protruding laterally; body light yellow-orange, with orange dorsal stripe and adjacent pale yellow dorsolateral lines; anal plate grey, grading to pink posteriorly; a series of light brown dorsolateral setae; series of translucent ventrolateral setae.

*Third instar larva* (Figs 14-15). 9-10 mm long, 4 mm wide; head light orange-brown; abdominal segment 12 protruding laterally; body pale pink with deeper pink narrow dorsal stripe widest at segments 5 and 10; abdominal segments 11-13 flattened, apple green rimmed with pink; coarse short brown dorsal setae.

*Fourth instar larva* (Figs 16-17). 14-15 mm long, 5 mm wide; head light brown; abdominal segment 12 protruding laterally; body pale pink with deeper pink dorsolateral stripes and apple green dorsal stripe; abdominal segments 11-13 flattened, grey-green rimmed with pink; short sharp dorsal brown spines, angled posteriorly.

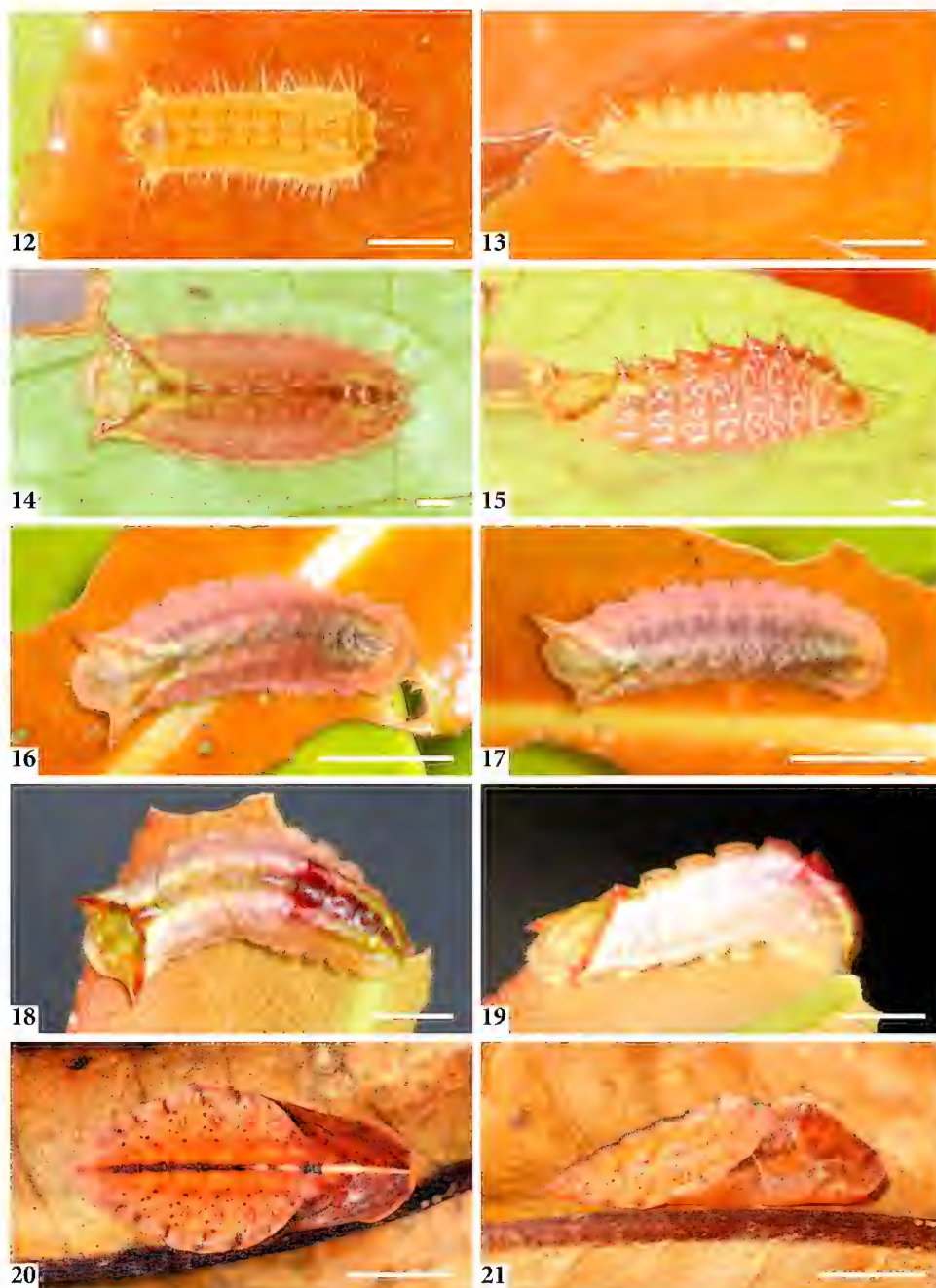
*Fifth instar larva* (Figs 18-19). 19-20 mm long, 6-7 mm wide; head light brown; abdominal segment 12 protruding laterally; body pale pink with deeper pink lateral stripe and conspicuous dorsal stripe that is apple green in segments 7-9 and crimson in segments 1-6, forming broad crimson saddle in segment 5; abdominal segments 11-13 flattened, apple green rimmed with deep pink; short sharp dorsal spine in segment 5, sharp dorsal ridges in segments 6-10. Total larval duration 19-22 days.

*Pupa* (Figs 20-21). 15-16 mm long, 7-8 mm wide; anterior flanged, with median indentation dorsally; abdominal segments strongly flanged; mesothorax with prominent dorsal ridge; abdominal segments dorsally ridged, indented between segments; orange-fawn, faintly speckled with brown, narrow white dorsal stripe on head and mesothorax, narrow dark brown dorsal stripe on abdominal segments; spiracles and between abdominal segments brown; wing cases rimmed with dark brown dorsolaterally. Attached by cremaster and silken girdle between segments. Pupal duration 13-15 days.

## Discussion

*Candalides insanae* appears to be the largest species in the genus, with specimens of both sexes attaining forewing lengths of up to 21 mm. Both sexes are quite similar in phenotype, unlike other members of the genus, thereby suggesting the possibility of representing an early lineage within the *absimilis* species group. Only minor variation is noted in a long series of both sexes, with some females having slightly more extensive green scaling extending into the apical area of the forewing upperside than that figured.





**Figs 12-21.** *Candalides insanae* early stages: (12-13) second instar larva: (12) dorsal view; (13) lateral view. (14-15) third instar larva: (14) dorsal view; (15) lateral view. (16-17) fourth instar larva: (16) dorsal view; (17) lateral view. (18-19) fifth instar larva: (18) dorsal view; (19) lateral view. (20-21) pupa: (20) dorsal view; (21) lateral view. Scale bar = 1 mm (Figs 12-15); 5 mm (Figs 16-21).



Regular surveying in the Whiteman Range (Fig. 5), at a range of altitudes over a three year period, recorded only a limited number of *C. insanaea* adults. Where observed, both sexes flew high and directly and seldom settled. All specimens flew over ridge tops between 1000 and 1200 m during mid-morning to early afternoon when the sun was brightest. The Whiteman Range is renowned as one of the wettest parts of Papua New Guinea and often experiences weeks, sometimes months, of relentless heavy rain and strong winds with no sunshine, particularly during the winter months. At the elevations where *C. insanaea* occurs, temperatures during this period usually sit around 15°C during the day and night. Adults of *C. insanaea* have been recorded flying from the beginning of October to the end of May.

Females of *C. insanaea* oviposit early in the afternoon and eggs are deposited on or near new growth of the food plant (Fig. 7), either singly or in pairs (Fig. 8). Females usually lay one or two eggs and then disappear on long-ranging flights before returning briefly to continue ovipositing. Eggs are most commonly deposited at the base of leaf stems but are sometimes placed on branches, on the undersides of leaves or on debris trapped among the foliage. Upon hatching, first instar larvae migrate to the fresh tips of the new growth and begin feeding, creating narrow troughs within which they are well disguised. Larvae feed throughout the day and night on new growth of the food plant, sheltering on the undersides of mature leaves during ecdysis. The larvae are capable of moving very quickly and move easily between flushes of new growth on different widely spaced branches. Larvae of *C. insanaea* were never seen to be attended by ants. Upon maturity, larvae turn wholly purple-pink and wander for at least 24 hours in search of a pupation site. In captivity, when sleeved on branches of the larval food plant, the larvae invariably selected curled dead leaves provided in which to pupate. Adults often emerge in the evening, just prior to sunset. However, adults will also emerge during the day, from 1000h.

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